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ONEONTA BLUFFS ON THE COLUMBIA RIVER.

THE GREAT RIVER OF THE NORTHWEST.—[SEE PAGE 392.]

SIX AVIATION ENGINES.

THE ALEXANDER PRIZE FOR AERONAUTIC MOTORS.

On October 19th, 1909, Mr. Patrick Y. Alexander, of London, offered a prize of one thousand pounds ($4,860) for a motor suitable for aeronautical purposes. The engines were required to be delivered at the National Physical Laboratory not later than July 1st, 1910. Six engines were originally entered for the competition, but of these only three were delivered by the date named. These were entered by the Wolseley Tool and Motor Car Company, Limited; Humber, Limited; Green's Motor Patents Syndicate, Limited. The committee, of which Mr. R. T. Glazebrook was chairman, found that the essential conditions of the test were in no case fully complied with. Two of the engines failed to complete the twenty-four hours' run required, and were therefore not subjected to the further tests specified in the regulations. The third engine, entered by the Green's Motor Patents Syndicate, completed the twenty-four hours' run, but the mean power maintained was 31.5 instead of 35 horse-power required.

The Wolseley engine submitted was one especially designed for aeroplanes. It has four cast-iron cylinders, 3¾ inches bore by 5½ inches stroke, mounted on an aluminium crank case. The water jackets are not cast solid with the cylinders, but are formed by bolting planished steel plates around the cylinders. The big ends of the connecting rods are of phosphor bronze, lined with white metal. The valves are underneath and on the same side with the motor, and are operated from the cam shaft by hardened steel tappets. The float chamber for the gasoline supply is arranged concentrically with the jet, so that the level of the gasoline below the jet is constant for all usual inclinations of the engine. A high-tension magneto supplies the current for ignition. The cooling is by convection. The engine is lubricated on the forced-feed principle, by means of a gear pump. The weight is 242 pounds.

This Wolseley engine ran very smoothly, doing 36 brake horse-power at 1,443 revolutions for two hours. It was then discovered that a copper oil pipe, leading from the pump to the oil well, was leaking. The company's engineer in charge decided not to stop, and after twenty minutes disconnected and blanked this pipe while running. The leak interfered with the oil supply to the bearings, for the engine began to run irregularly, and finally stopped, after having run three hours and two minutes, when it was found that the white metal of one of the connecting-rod bearings had melted. In accordance with the regulations, the motor was thereby disqualified. A new bearing was fitted and another trial started, at the request of the company, several days later. The engine ran very well for four hours, and then began to run irregularly. After five hours of the test, a stop was made and a new spark plug fitted to one cylinder. This was repeated after another hour's run, but without improving matters, the trouble being attributed to a faulty radiator. After six hours of the test, there was a stop of 50 minutes. The radiator was emptied and refilled. On restarting, the engine ran for six hours and then failed. After three more short runs of 23 minutes, 92 minutes, and 38 minutes, it was observed that the cooling water was rapidly disappearing. The engineer in charge then decided to stop and examine the cylinders. On applying water at about 5 pounds an hour pressure to the jackets, it was found that the water was making its way into all four cylinders through cracks in their upper ends. The test was therefore discontinued after a total run of 17 hours 41 minutes, including seven stops aggregating 2 hours 18 minutes.

The Humber engine is of the four-cylinder water-cooled type. The cylinders are of cast iron, 110 millimeters bore, with a stroke of 120 millimeters. The cylinders are cast separately, and surrounded by copper water jackets. The valves are placed in the cylinder head and operated by concentric valve rods, the outer rod operating the inlet valve and the inner rod the exhaust. The cam operating the outer tappet is forked on the two sides of the cam operating the inlet. The springs of the inlet valve are inclosed in cases over which is fitted the inlet pipe. The exhaust valve springs are laminated cantilevers bolted on to bridges spanning two cylinders. The carbureter has a float chamber which, however, is not concentric with the jet. It is of the single-jet type with automatic air control. The ignition is by high-tension magneto. The circulation in the jackets is maintained by a water circulating pump driven from the same spindle as the magneto. The lubrication is forced; a small pump draws oil from the base of the crank case and delivers it through jets inside the crank case, these being so placed that the oil squirts on to the big ends of the connecting rods and sprays from these round the engine. Ball bearings are used for the five main bearings, and there is a thrust race at either end of the crank shaft to admit of the use of either a propeller or a tractor.

The erection of this engine was commenced on September 19th, and a preliminary run was made on September 21st. On September 22nd the assistant manager of the company asked for permission to fix another radiator, as the one sent in with the engine was inadequate. He was informed that the committee might take a serious view of such an alteration, and that the company must make any alteration on their own responsibility. On September 23rd another radiator was fixed, which the competitors considered satisfactory, and, after a preliminary trial, the endurance test was begun September 26th, at 9:45 A. M.

After running for 16 minutes, as the ignition in one cylinder was not satisfactory, a stop of two minutes was made, and a new sparking plug fitted. The engine then ran steadily, doing 37 B.H.P. at 1,224 revolutions per minute for 11¼ hours, when the engine suddenly failed, and on external examination was seen to be completely wrecked, with one of the cylinders broken off. The only attention to the engine during this period was the addition of 12½ pints of oil seven hours, and 50 pints eight hours, after the commencement of the trial. On the following day the engine was examined more in detail, and it was found that, in addition to the fractured cylinder, two connecting rods were buckled and the big end caps torn off, several holes were made in the crank casing, and the crank shaft was damaged. This accident, of course, brought the test of the Humber engine to a conclusion.

The Green engine has four separately mounted cast-steel cylinders, machined inside and out, of 105 millimeters bore, with a stroke of 120 millimeters. The water jacket consists of a thin copper helmet, the joint with the cylinder at its lowest end being by a rubber ring fitting into a groove in the cylinder, so that the expansions of cylinder and helmet are independent. The cylinders are mounted on an aluminium crank case, the holding-down bolts being carried through to serve as supports for the crank-shaft bearings. The valves are of the mushroom spring-closed type, in detachable cases. Each valve is inclosed within a small dome, having an orifice through which the valve is actuated by the end of a short tappet pin. The cam shaft is carried in bearings in a small oil-tight horizontal casing, divided into halves, and is rotated by an incased vertical spindle situated in front of the engine. This spindle is driven by a pair of worm-wheels from the crank shaft. The rocking levers are pivoted in extensions of the cam-shaft case, their striking ends being provided with adjusting screws, and the ends operated by the cams with rollers. This has no float chamber, and its action is independent of the inclination of the engine. It is of the single-jet type, and has automatic air control. The ignition is by high-tension magneto. The engine is water-cooled, the circulation being effected by a gear pump. The main oil channel is cast solid with the crank case, and from this oil is forced by a small gear pump through leads at right angles communicating directly with each of the hollow columns through which the holding-down bolts pass, and thence to the main bearings and crank shaft, the latter being hollow. By this system the use of separate pipes is dispensed with. The crank shaft is provided with bearings between each throw, and is slightly offset from the center line of the cylinders. The ball race is designed to be used with either a propeller or a tractor. Weight, 219 pounds.

The erection of the engine was commenced on October 5th, but, owing to unavoidable delay, the preliminary run was not made until October 17th. The endurance test was commenced at 10:30 A. M. on October 18th. The engine did not run very satisfactorily during the first hour, owing to difficulties with the ignition, and after one hour's run a stop of ten minutes was made, during which new sparking plugs were fitted. On restarting, the engine ran much better, and continued making approximately 31.5 B.H.P. at 1,213 revolutions per minute, until the completion of the 24 hours' run on October 19th. The only attention to the engine during this period was the addition of 42 pints of oil 17 hours after the commencement of the trial, and an additional 21 pints 22 hours after the commencement of the trial.

The maximum horse-power which could be maintained for seven minutes was determined on the same day without any overhauling of the engine, with the exception of grinding in the valves. The horse-power obtained was 36.4 at 1,390 revolutions per minute.

To test the effect of the gyroscopic action of the propeller a couple of 50 foot-pounds in a vertical plane was applied to the motor shaft for three minutes while the engine was running, but no effect on the speed and torque could be detected.

To determine whether the engine would work satisfactorily when tilted about an axis transverse to the shaft, two runs of an hour each were made on the engine when tilted at an angle of 15 deg., first one end, and then the other end, being uppermost. The competitors did not wish to run their engine at full load during this test, and maintained the B.H.P. at approximately 18 throughout both trials. The engine ran steadily in both cases, but it was noticed that the exhaust was decidedly smoky, apparently indicating over-lubrication.

The general steadiness and freedom from vibration of the engine when running were so marked that it was not considered necessary to test it when running and placed on elastic supports.

On the completion of the trials the engine was dismantled, and the working parts thoroughly examined. Very little wear could be detected in the crank-shaft and connecting-rod bearings, and the state of the cylinders and valve appeared to be quite satisfactory. The ball races of the thrust bearing at the propeller end of the crank shaft were, however, considerably worn. In the crank-shaft bearings one of the aluminium caps was cracked right through for about one-third of its length. It was not certain that this crack had originated during the National Physical Laboratory tests, as there was some evidence that it existed before these trials began, but it appeared probable that the crack had become larger during the tests. In the case of one of the connecting rods, it was found that the sleeve inside the small end of the rod had rotated, so that the oil way to the pin was blocked up, and, further, the gudgeon pin had moved sideways and was rubbing against the sides of the cylinder.

MANUFACTURE OF RADIUM SALTS.

An English patent has been taken out by F. Ulzer and R. Sommer on the manufacture of radium salts or compounds and substances containing large proportions of radium. The material containing radium is first treated with concentrated sulphuric acid, for a longer time (some weeks) at normal temperature or a shorter time (several hours) at boiling temperature, or it is fused with acid sulphates, and the residue, remaining after repeated washing, is boiled, under pressure, with concentrated solutions of caustic alkalis or alkali carbonates, or is melted therewith; the melt is treated with water, and, after further repeated washing, the residue is boiled with dilute sulphuric acid. Or, the same effect may be obtained by treating first with alkaline agents and then with acid agents. In either case, a residue of only about half a per cent remains, in which nearly all the radium is contained as sulphate, and the process can be carried out in a very short time, and with little difficulty. As an example: 100 kilogrammes of finely ground pitchblende residue are heated with about 400 kilogrammes of crude concentrated sulphuric acid for several hours, until the acid begins to fume; when the dark brown color of the mixture has changed to light brown or gray, the mass is introduced into ten to twenty times the quantity of water, boiled, left to stand, and the solution decanted. The residue is washed twice with water, collected on a filter, dried, and the dry mass, weighing 45 to 50 kilogrammes, is heated with 130 to 150 kilogrammes of commercial sodium hydroxide in iron crucibles, until (generally in one to two hours) a uniform melt is obtained, and this is boiled several times with water (about 1,000 liters each time), after which it is left to stand, decanted, and filtered. The moist residue is boiled with about 5 kilogrammes of dilute sulphuric acid (20 per cent), and is then filtered and washed, about 0.5 kilogramme of crude sulphates being obtained. Other examples are given. The crude sulphates may be converted quickly and almost completely into chlorides by fusing with alkali carbonates, washing, filtering, and dissolving the residue in pure hydrochloric acid. The crude chloride obtained by evaporating this solution may, for making bathing preparations, be left to stand alone, or with the addition of other known bath admixtures in solid or liquid form, in air-tight vessels, until the highest activity is reached.

THE MECHANICAL THEORY OF NATURE.

RELATIONS OF MODERN PHYSICS TO THE MECHANICAL INTERPRETATION OF NATURE.

BY PROF. MAX PLANCK.

The theory of natural phenomena which has hitherto afforded the greatest service to physics is unquestionably the mechanical theory, which aims to reduce all physical processes to movements of similar elements of mass. There have always been skeptics, who doubted the fundamental character of such a formulation of the problem, and regarded the mechanical theory as too narrow to embrace the infinite diversity of natural phenomena. Hitherto it could not be said, with truth, that either of these opposing views had obtained any decided preponderance over the other. Now, however, a final decision appears to be promised as the result of a new movement in theoretical physics—a movement of so radical and revolutionary a character that its influence extends far beyond the confines of the science of physics into the neighboring realms of chemistry and astronomy, and even into the theory of cognition, and that it threatens to provoke a controversy comparable only with that which was waged over the Copernican theory of cosmogony.

The mechanical interpretation of nature derived its strongest impulse from the development of the kinetic theory of gases and the atomistic theory of matter, which have become indispensable for the explanation of many phenomena, such as the Brownian molecular movement and radioactive transformations. In thermodynamics, chemistry and the theory of electrons, the mechanical interpretation is firmly intrenched. On the other hand, there is a large class of physical phenomena which have been investigated with the utmost accuracy and which appear to oppose insuperable obstacles to mechanical interpretation. These are the phenomena which require for their mechanical interpretation the hypothesis of a material luminiferous ether. The existence of a material ether is a necessary postulate of the mechanical theory, according to which there can be no energy where there is no motion, and there can be no motion where there is nothing to move. But the ether must be totally unlike any known material substance. It must possess an almost infinitely great elasticity, combined with an almost infinitely small density, in order to explain the exceedingly great velocity of light. In Huygens's theory of light, which assumed the rotations to be longitudinal, or in the direction of propagation, the ether could be conceived as a very rare gas, but after Fresnel had proved that the vibrations of light are transverse it became necessary to regard the ether as a solid, because transverse vibrations cannot be propagated in a gas. This solid ether, however, must possess the property of opposing no perceptible resistance to the movement of the heavenly bodies.

This is only the first of the difficulties. The problems of the constitution of the luminiferous ether, its density and elasticity, the existence of longitudinal ether waves, the velocity of the earth's atmosphere relatively to the ether, have been diligently investigated by experimenters and theorists during many years without yielding any positive result.

Whether the ether is regarded as a continuous substance or as composed of separate atoms, the question remains whether the ether contained in a moving transparent body moves with the body, or lags behind or remains absolutely at rest.

It is quite certain that the ether does not always share the motion of the containing body and that in many cases it is practically undisturbed by such motion. The velocity of light is not affected by the movement of the air which it traverses or, in other words, light travels as rapidly against the wind as with the wind. Hence we must infer that the ether which conveys waves of light through the air is not appreciably affected by the movement of the air, but remains at rest while the air streams through it. This conclusion suggests another question: How fast does the earth's atmosphere move through the ether? This question has never been answered by direct measurement. The atmosphere, as a whole, moves with the earth round the sun, with an average relative velocity of about 18 miles per second, and in a direction which continually changes with the season. Although this velocity is 10,000 times smaller than the velocity of light, it is possible to devise optical experiments by which it could be measured. Attempts to measure the movement of the earth relatively to the ether fill many pages in the annals of physics, but the skill and acumen of every experimenter have been defied by the obstinacy of fact. Not the slightest influence of the earth's motion upon the course of optical phenomena within our atmosphere has ever been detected. The most striking negative result is that of Michelson's experiment, in which the velocity of light in the direction of the earth's motion was compared with its velocity in the perpendicular direction. This experiment was so simple in principle, and the method of measurement was so exceedingly delicate, that any effect due to the earth's motion should have been clearly perceptible, but no such effect was discovered.

In this dilemma it is permissible to speculate whether it would not be better to view the problem from a totally different standpoint and to ask how theoretical physics would be affected by the abandonment of a material ether and the assumption that light is propagated through space without the aid of any material medium.

This assumption destroys the universality of the mechanical theory of nature and leads to the principle of relativity which in turn leads to a radical and revolutionary change in the conception of time. According to the principle of relativity no physical meaning can be given to an interval of time without taking into account the motion of the observer to whom that interval applies.

This consequence of the principle of relativity, according to which time, like velocity, is only relative, appears at first sight monstrous and incredible, but not more so, perhaps, than the assertion that the vertical direction at any point of the earth's surface is not a fixed direction, but traces a cone in space every 24 hours, would have appeared 500 years ago.

The criterion by which a new theory must be judged is not its plausibility, but its fertility. In this respect the principle of relativity, despite its youth, appears very promising. The pioneers of the new theory are H. A. Lorentz, who first conceived the idea of relative time and applied it to electrodynamics; A. Einstein, who boldly generalized the principle and proclaimed the relativity of all intervals and epochs of time, and the late H. Minkowski, who showed that the doctrine of the relativity of all velocities is merely an extension of the doctrine of the relativity of all distances and directions.

According to this view the physical universe which is accessible to our observation possesses four perfectly co-ordinate and interchangeable dimensions, of which three are included in the name space and the fourth is called time.

The physical acceptability of this view can be decided only by experiment. Whatever the final decision may be, whether the principle of relativity is accepted or rejected, whether we are standing at the threshold of an entirely new interpretation of nature or not—we must at least acquire a clearness of view for which no price is too high. Even a disillusionment, if it is fundamental and final, marks a step forward, and the sacrifice of old belief will be richly recompensed by the acquisition of new treasures of knowledge.—Umschau.

Correspondence.

CUBE ROOTS OF CIPHER POWERS.

To the Editor of Scientific American Supplement:

Permit me to submit for publication what I believe to be a new simplified method of determining the cube root of a cipher power. The process of finding the root has always been a tedious one to experts as well as to beginners, so much so that most calculators prefer the solution by logarithms. As I have as yet never come across a like method, I am led to believe that it is original with me. Should this be a delusion, I shall be satisfied to console myself with the conviction that it will be a welcome and useful disclosure to those who are like myself not aware of its existence.

For illustration note the following example:

		$\sqrt[3]{41\ 135\ 081\ 408} = 3452$
9	2700	14 135
94	3076	12 304
98	346800	1 831 081
1025	351925	1 759 625
1030	35707500	71 456 408
10352	35728204	71 456 408
		0

The evident advantage of this method rests in the arrangement, which does not permit of confusion, as trial and true divisors and their respective dividends are at all times in perfect alignment. The process expressed in words is as follows:

The figure is first pointed off into periods of three digits each, and by inspection 3 the first digit of the root is determined. The cube of 3 or 27 is then subtracted from 41 synthetically, the remainder being 14, to which we annex the ciphers of the second period. 14135 now becomes our second dividend, the first being 41. We now proceed to construct the first trial divisor in this manner: At the head of column 1 we place 3 times the first cipher of the root, 3 in this case. 3 times 3 = 9. Thus 9 becomes the head of column 1. At the head of column 2 we next place the product of the first figure of the root and the head of column 1, or 3 times 9 = 27. Thus 27 becomes the head of column 2. By adding two 00, or rather annexing two zeros, we have 2,700, which is our second trial divisor. It is well to remark right here that in order to avoid that confusion so prevalent in other methods, the first and second columns of the trial divisor should always be arranged, exactly as in the illustration, in line with the dividend. Resuming the operation, we find that 2,700 is contained in 14,135 about 4 times. 4 then becomes the second cipher of the root. Annexing now 4 to 9 in column 1 we have 94, which we place under the 9 as illustrated. Multiplying 94 by 4, we obtain by a process of contemporary multiplication and addition, which is explained later under this heading: 3,076. Suffice it to say at present that 3,076 is the result of 4 times 94 + 2,700. Having 3,076, we next multiply it by 4, thus 3,076 times 4 = 12,304. Now it is easily seen that 3,076 is the true divisor. Subtracting 12,304 we obtain a remainder of 1,831, to which we annex the three ciphers of the third period, or 1,831,081, which represents the third dividend. Again we proceed to construct the third trial divisor.

Adding 4 in column 1, we have 98, and 4 times 98 added to 3,076 = 3,468. Annexing 00 we have 346,800, our third trial divisor, which by inspection is contained in 1,831,081 about 5 times. Adding 4 for the last time in column 1 and annexing the third cipher of the root 5, we obtain 1,025; 5 times 1,025 + 346,800 = 351,925, which is our third true divisor, and which we place into column 2. Five times 351,925 = 1,759,625; subtracting from trial dividend we have for a remainder 71,456. To this we annex the fourth period of three ciphers, or 71,456,408, which represents our fourth dividend. Adding 5 in column 1 we have 1,030, and annexing 00 to 357,075, which is the result of 5 times 1,030 + 351,925, we obtain 35,707,500, our fourth trial divisor, which by inspection is contained in 71,456,408 about twice. Adding 5 for the last time in column 1 and annexing 2, the fourth cipher of the root, we have 10,352. Now twice 10,352 + 35,707,500 = 35,728,204, and twice 35,728,204 = 71,456,408; this subtracted from our fourth dividend leaves no remainder. Therefore 3,452 is the true root of 41,135,081,408. I still have left unexplained how I perform the contemporary multiplication and addition. The process expressed in words is as follows:

4 . 94 + 2,700 = 3,076

4 times 4 = 16 and 0 = 16, 1 to carry. 4 times 9 = 36 and 1 to carry makes 37, and 0 = 37. 3 to carry and 7 = 10, 1 to carry and 2 = 3. Thus our ciphers reading from right to left are 6, 7, 0, and 3, or reading from left to right 3,076.

As it will be easily seen, this method requires no extra sheet of paper, and in number of lines does not exceed that of long division.

It is purely mechanical, and all operations are consecutive in the logical order, and the mental strain involved in the dominant methods is lightened to a considerable degree.

Richard J. Schloming.

Portland, Me. Chief Engineer Merchant Marine.

According to the Zeitschrift für das gesamte Turbinenwesen a water power station has just been completed at the Bullersfors Falls, in Dallafluss, by a company which are supplying most of the electrical energy to the Domnarfoet ironworks, where important experiments in electrical smelting and refining have been recently carried out, and to the Kvarnsveden paper mills. The total output of the station will be 24,000 horse-power. There are six generating sets of 4,000 horse-power each, running at 180 revolutions per minute. Three-phase current is generated at 7,000 volts, 60 cycles.

THE TELEPHONE AND THE RAILROAD.*

TRAIN DISPATCHING BY TELEPHONE.

BY G. K. HEYER.

PRIOR to October, 1907, the telegraph was used almost exclusively for dispatching trains on the more important of the trunk line railways of the United States. It is somewhat surprising that the value of the telephone for this work was not generally acknowledged by the larger roads at an earlier date, as several of the shorter railroads have for a number of years used the telephone for handling traffic and have obtained very satisfactory results.

Among the roads which previous to three years ago used the telephone for controlling train movements are the New Orleans & Northwestern and the Huntingdon & Broad Top Mountain railroads, both of which installed telephone circuits as long ago as 1883; the New York & Pennsylvania Railway, the Chicago, Kalamazoo & Saginaw, and the Lake Erie, Alliance & Wheeling.

The telephone equipment used in these early installations was far inferior to that at present found in railway circuits. The great improvements which have been made in the past two or three years in the apparatus, together with the development of new apparatus to meet special requirements of railway service, indicate that the usefulness of the telephone for this branch of service has only begun.

The telegraph, as is well known, was used for dispatching trains as early as 1850, previous to which date the "time interval" system was used to handle train movements. The rule was that a ruling train had the right of one hour against an opposing train of the same class.

The following extract from Edward Harold Mott's history of the Erie Railroad, entitled "Between the Ocean and the Lakes," tells how trains were advanced under this system and also describes in detail how the first train on the Erie was dispatched by the use of the telegraph:

Conductor Henry Ayres had lost his hour at Pond Eddy. He took the switch, and, after waiting ten minutes, as was the rule, and the opposing train not being in sight or hearing, he started a brakeman with a red flag, and giving him twenty minutes start, followed with his train. A little west of Shohola he caught the flagman, who had stopped on enough straight line to make it safe. The exhausted man was taken aboard the train and a fresh man started on with the flag, which operation was repeated until the train expected was met at Callicoon, thirty-four miles from Pond Eddy. Captain Ayres used to say that he had flagged the entire length of the Delaware Division more than once.

The telegraph was first used when W. H. Stewart was running the westbound express train. On the day when Superintendent Minot made his astounding innovation in railroading he happened to be going over the road on that train. The train, under the rule then existing, was to wait for an eastbound express to pass it at Turner's, forty-seven miles from New York. That train had not arrived, and the westbound train would be unable to proceed until an hour had expired, unless the tardy eastbound train arrived at Turner's within that time. There was a telegraph office at Turner's, and Superintendent Minot telegraphed to the operator at Goshen, fourteen miles farther on, and asked him whether the eastbound train had left the station. The reply was that the train had not yet arrived at Goshen, showing that it was much behind time. Then, according to the narrative, Superintendent Minot telegraphed as follows:

To Agent and Operator at Goshen:
Hold the train for further orders.
CHAS. MINOT, Superintendent.

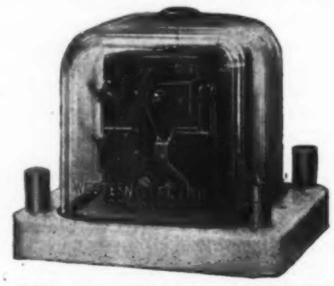
He then wrote this order and handed it to Conductor Stewart:

To Conductor and Engineer Day Express:
Run to Goshen regardless of opposing train.
CHAS. MINOT, Superintendent.

"I took the order," said Mr. Stewart, relating the incident, "showed it to the engineer, Isaac Lewis, and told him to go ahead. The surprised engineer read the order, and, handing it back to me, exclaimed:

"'What do you take me for? I won't run by that thing.'

"I reported to the superintendent, who went forward



THE TELEPHONE SELECTOR.

and used his verbal authority on the engineer, but without effect. Minot then climbed on the engine and took charge of it himself. Engineer Lewis jumped off and got in the rear seat of the rear car. The superintendent ran the train to Goshen. The eastbound train had not yet reached that station. He telegraphed to Middletown. The train had not arrived there. The westbound train was run on a similar order to Middletown, and from there to Port Jervis, where it entered the yard from the east as the other train came into it from the west."

An hour and more in time had been saved to the westbound train, and the question of running trains on the Erie by telegraph was at once and forever settled.

That the telegraph has performed its extensive work of regulating railway traffic everywhere in a satisfactory manner, there is no one who will deny. To one familiar with railway operation the thought of train dispatching has always carried with it the thought of the telegraph. Up to a year or two ago the young man starting out in life with the idea of some time occupying an official position in the railway world considered the mastery of the Morse code one of the first steps in the direction of the coveted goal.

Since the telephone has begun to supplant the telegraph on many of the most important railroads of the country there have been many fears on the part of people used to the ways of railway telegraph that the new system would interfere with the positions of many railway employees. These fears, however, have proved groundless, and the following extract from an article written by Mr. C. H. Gaunt, formerly of the Santa Fé Railway, and printed in the Santa Fé employees' magazine, expresses very clearly what has been the experience of many dispatchers under the telegraph system:

The telegraph is used by the train dispatcher in the intricate operation of his trains for one purpose only, that of communicating with the operators scattered along the stretch of railroad. Long use has developed a certainty of action in telegraph manipulation that commands the respect of all. But how often has a half frantic dispatcher, loaded down with the complicated problems before him, wished he could use his voice to the men with whom he must communicate and thus avail himself of the rapidity of action, the definiteness and security that would follow?

Among early installations of the improved telephonic apparatus for dispatching trains were those on the New York Central, as early as October, 1907, and the Chicago, Burlington & Quincy, which in December of that year installed the telephone along forty six miles of its main road in Illinois. These early installations produced conclusive proof of the superiority of the telephone, and this was the proof for which railroad men so long had been waiting. The extent to which the telephone is being used is shown by the following list of roads which now are operating telephone circuits covering over 1,000 miles:

	Miles.
Atchison, Topeka & Santa Fé	6,083
Lake Shore & Michigan Southern	2,000
Pennsylvania Railroad (east of Pittsburg)	1,407
New York Central (including Boston and Albany)	1,255
Big Four	2,500
Illinois Central	2,100
Canadian Pacific	1,694
Great Northern (will eventually have)	6,000
Chicago, Milwaukee & St. Paul System	1,300
Louisville & Nashville	1,261

It can easily be seen that it is only a matter of a few years when the telephone will entirely replace the telegraph for dispatching of trains as well as for the transaction of all local commercial message and routine business.

A comparison of the two systems of handling train movements cannot fail to show the advantages of the telephone method. In the first place, orders are issued verbally by the dispatcher in place of being sent out in code, and this cannot fail to insure better understanding. The speed which may be obtained is limited only by the ability of the operator to copy the messages. It is a well-known fact that the rate of sending attained by the average telegraph operator is considerably less than fifty words a minute, and the majority will fall much below this figure, while with the telephone a speed of eighty to one hundred words may be obtained. Experience has shown that fourteen to sixteen train orders may be put out in one hour with the telephone, whereas with the telegraph a dispatcher was doing exceedingly well to send out half this number.

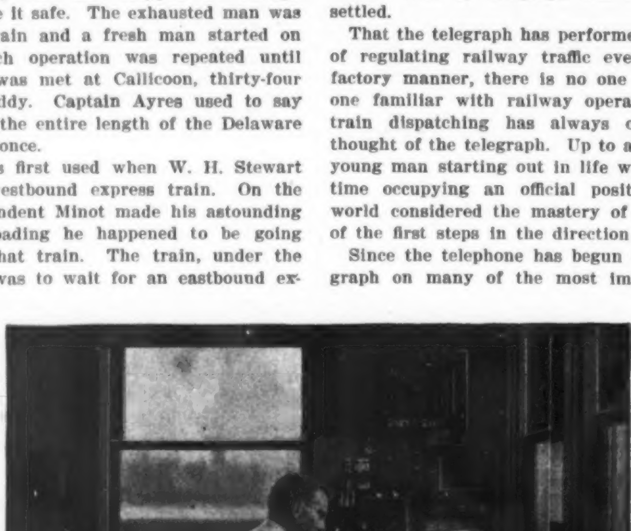
Another advantage is the use of portable telephone sets, which enable the conductor to get into immediate touch with the dispatcher in case of a breakdown or other trouble between stations. With the telegraph it was of course necessary to reach the nearest telegraph office in order to send in a call for help.

Since the telephone has been used for the directing of train movements, not only since 1907, but also previous to that date, when the equipment had not reached its present state of perfection, not a single accident has been reported resulting from the use of the telephone.

Greater accuracy in transmitting orders is insured by the telephone method, as the dispatcher writes down the words as they are spoken, thus completing his record as the order is given and checking this record, word for word, as the order is repeated back by the operator.

With the telephone the dispatcher is in closer personal touch with the men along his line than with the telegraph. A message by Morse is a bare, cold statement, while with the telephone the inflections of the voice have a great deal to do with the spirit in which remarks are taken. The number of sharp remarks over the wire has greatly decreased, or such occurrences have stopped altogether since the installation of the telephone on some of the trunk roads. Those not familiar with railroad work can easily understand this, since they know how much more satisfactorily any conversation may be carried on by telephone than by making use of either the telegraph or the mail.

The eight-hour law enters in as a factor in the railroad dispatching situation. Federal and State laws limiting the working days of the railroad employees occupied in the receiving and transmitting of



TRAIN DISPATCHER ON THE LAKE SHORE.

* Abstract of paper read before the Engineers' Society at Harrisburg, Pa.

orders effected a considerable increase in the number of men necessary for handling the work. Even before the passage of these laws the field from which the railroad companies could draw operators was none too large, and the introduction of the telephone has lifted a considerable burden in this particular. Men can be taken from other departments since the requirements no longer make necessary the ability to read and send Morse. At the same time a field of employment has been opened to trainmen and other employees who have met with accidents which incapacitate them from their previous employment.

Along the Pacific coast, where heavy salt fogs make the operation of the telegraph almost an impossibility, the telephone has been operating satisfactorily along the lines of both the Santa Fé and Southern Pacific. During these severe rains and snow storms in the East last winter there were several instances in which the only wires available for communication on some of the railroads were the telephone wires.

In summing up such a comparison as this, the advantages which must be conceded to the telephone method of operation are, that it is quicker, safer and more reliable.

Apparatus has been developed to meet the requirements of railway service, opening up a new field of endeavor among telephone manufacturers. The feature of vital importance in telephone train dispatching is the manner in which the lines are constructed and maintained. The best of copper wire is used and metallic circuits are found necessary.

The superintendent of telegraph of the Seaboard Air Line recently reported that between Raleigh and Monroe, a distance of 150 miles on the telephone line of that road, the ticking of a watch held up to the transmitter at the end station was distinctly heard in the dispatcher's office. This shows something of the efficiency of telephone train dispatching circuits.

The selector which has been developed especially for train dispatching service is an ingenious device which permits of the calling separately of each of the stations along a single telephone line. A number of these selectors have been developed, all with a view to obtain speed in calling the different stations.

Seated in his office the dispatcher uses sometimes a chest transmitter, sometimes a transmitter arm with a head receiver and cord and plug. Sometimes he is provided with a foot switch, leaving both his hands free to manipulate his train sheet. The majority of roads arrange for bringing into the dispatcher's office spare wires which may be used in emergency for patching around any points on the line which develop trouble, such as short circuits, grounds and opens.

A HORSESHOE ROLLING MACHINE.

A SUBSTITUTE FOR HAMMER AND ANVIL.

BY THE BERLIN CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

The horseshoe rolling machine recently brought out by the Eisenwalzwerk Ransa, Ltd., of Bremen, allows horseshoes to be automatically produced in a single complete operation from iron bars cut to proper length and raised to a red heat.

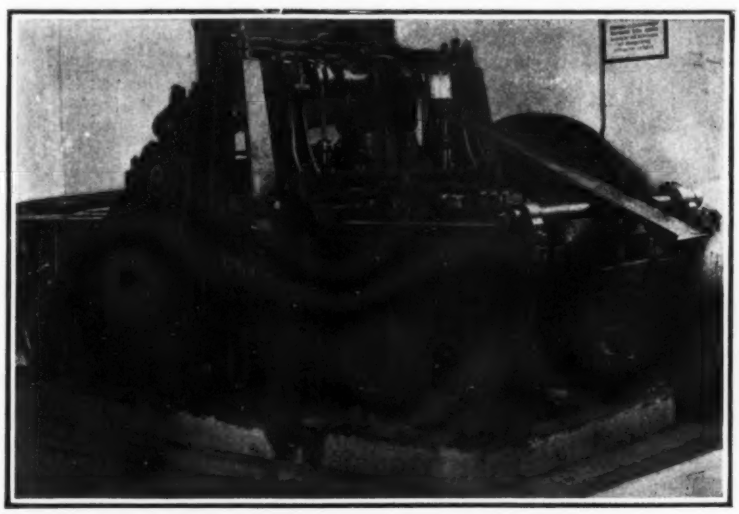


Fig. 1.—HORSESHOE ROLLING MACHINE. PRODUCES 2,000 TO 3,000 SHOES COMPLETE IN TEN HOURS' SHIFT.

It comprises a work-table free to move throughout the length of a substantial frame. A rack fixed to the underside of this table engages with a toothed wheel which, by turning alternately to the right and the left, carries the table forward and backward, according as a bevel wheel mounted on the same shaft is driven by one or other of the two bevel wheels loosely mounted on the driving shaft. The switching of these wheels and accordingly the reciprocating motion of the work-table is effected automatically by an ingenious mechanism.

On the work-table is fixed the lower part of the horseshoe fold, immediately behind which two rollers are free to move in a transverse beam rigidly connected with the frame. These rollers are acted upon by springs in the longitudinal axis of the machine. If now a red hot iron bar is inserted between the projecting (lower) part of the mold and a guard, it is bound to be bent by the rollers around that part, thus assuming the form of a horseshoe.

As the work-table continues on its forward move, the upper (hollow) part of the mold which is mounted loosely on a shaft is set rotating by toothed segments, being thrown at heavy pressure, over the curved iron bar lying on the lower (projecting) part. Being thus closely enchased, as though in a capsule, the bar accurately assumes the shape of the upper mold or matrix, while any surplus material is drawn out in a backward direction. This is a perfect rolling process, imparting to the lower side of the horseshoe the conical shape impossible to produce with any other horseshoe machine so far designed. Both the shaft and the hollow matrix mounted thereupon are readily adjustable, the latter being easily exchanged to fit any size and thickness.

The holes are punched into the horseshoe thus produced by dies actuated by eccentrics. In fact the slots of the work-table, by striking against stops, will cause these to drop, thus carrying along a slide and setting the eccentric rotating. After punching the hole, the slide is then released and reduced to its initial position.

After thus achieving its operation, the work-table advances another 200 millimeters (7.87 inches), while a set of pegs rising from slots in the lower part of the mold will lift the horseshoe produced. At the same time a plate is inserted between the lower part of the mold and the horseshoe for discharging the latter. The work-table then automatically reverses its course, thus causing the discharging plate to tilt and to drop the horseshoe, after which it returns into its initial position.

Fig. 2.—SPECIAL FURNACE FOR USE IN CONNECTION WITH MACHINES.

of proper length previously raised to a red heat is inserted at the front end of the machine in order to be discharged at the other end in the form of a horseshoe finished in all its details. The operation, as above said, is completed in one heat, without any interference of the two men superintending the service.

The whole operation is so designed that an iron bar

This machine is driven by a motor of only 7.5 horsepower, and accordingly is much cheaper in operation than any of the installations so far designed for the same purpose. Its dimensions are relatively small, its weight is about 9,000 kilogrammes (19.842 pounds).

The machine will perform five forward and backward runs per minute, thus allowing 2,000 to 3,000 horseshoes to be produced during a ten-hour shift. The horseshoes are perfectly finished in all their details, so that the task of the farrier is limited to fixing them to the horse's feet.

Fig. 2 represents a special furnace designed for use in connection with two horseshoe machines of the above type.

EXPERIMENTS IN DIAMOND MAKING.

La Rosa (Schweiz. Woch. Chem. Pharm. through Merck's Rep.) has endeavored to liquefy carbon with the singing electric arc current. Attempts which have been made to do this at ordinary atmospheric pressure by the electric furnace have been unsuccessful. La Rosa believes that a higher temperature can be obtained from the arc than the furnace. Pure sugar carbon used as an electrode for the intermittent singing arc exhibited crust formations which were necessarily formed from the fusion of small particles of carbon, so that the liquefaction of carbon was extremely probable. It was hence concluded to examine more closely whether using this method or by rapidly chilling the fused carbon, diamonds could be obtained. For this purpose a very powerful electric spark from a battery of 72 large Leyden jars was employed, and the author obtained from the powder from the sugar carbon, small crystalline formations exhibiting a specific gravity over 3.2, which very distinctly scratched a ruby, and hence possessed properties which could only be possessed by carborundum, or diamond. As the former, however, is entirely excluded, because of the absence of silica from the material employed in the investigation, the assumption was rendered very probable that diamond was the product of fused carbon at atmospheric pressure.

THE PHYSIOLOGY OF LIGHT.—I.*

SOME OF ITS OCULAR EFFECTS.

BY CHARLES PROTEUS STEINMETZ.

The most important physiological effect is the visibility of a certain range of radiation. In most applications of radiation we desire light, that is, the effect of visibility is the thing aimed at. All the other effects of radiation, therefore, are incidental, unthought of, undesired, or even harmful. It is important to the illuminating engineer to be familiar with all these physiological effects of radiation beyond mere visibility, so as to be able, in the illumination, to guard against those features which may be objectionable, or even harmful, and to benefit by the features which are desirable. During the last years considerable discussion has taken place on the harmful effects of radiation, more particularly of ultra-violet light, to such an extent, that in illuminating engineering ultra-violet begins to assume the same position which resonance once had in electrical engineering, to be the scapegoat which is blamed for everything we do not understand. However, it cannot be denied that artificial illumination is more harmful, more severe on the eyes, than daylight. In the last years a rapid advance has taken place in illuminating engineering. New illuminants of higher power, of a whiter color, that is, a color more nearly like daylight, hence of shorter wave length, than the illuminants of old, have been introduced. During the same years the frequency of affections of the eye, due to working under artificial illumination, has seriously increased. We also know that ultra-violet light is harmful. It is very easy, then, to draw the conclusion, and the conclusion has been drawn, that the increasing frequency of eye troubles is the result of the development of illuminants of shorter wave length or higher frequency of light, and due to the higher percentage of ultra-violet and harmful radiation, contained in these modern illuminants, as the tungsten lamp and the arc, compared with the gas flame and the kerosene lamp of old.

This is a very good illustration how a wrong conclusion can be drawn from facts which apparently warrant it. The conclusion that increasing frequency of eye affection is due to the shorter wave lengths, the greater whiteness of modern illuminants, is refuted by the fact that while in these modern illuminants we have succeeded in getting whiter light and the average wave lengths are shorter than before, daylight is still whiter and of still shorter wave length, and is harmless. The suggestion that the ultra-violet radiation contained in these modern illuminants may be guilty of the harm is refuted by the fact that daylight contains a higher percentage of ultra-violet light than any modern artificial illuminant in general use. You see here that we have conclusions apparently warranted by the facts, and still wrong, and easily proven wrong by comparison with the corresponding effect of daylight, which we know is harmless, because we have tried it for untold ages during the development of the human race.

In those days when the tallow candle was the best illuminant, affections of the eye, due to working under artificial illumination, obviously were unknown, because there was no illumination of such character that work could be carried on under it. With the advance of the art, and the development of better illuminants, it became more and more possible to do close work under artificial illumination, and as a result more and more eye affections became possible by working under artificial light, until ultimately, in the last few years, we have succeeded in producing illuminants with an intensity and a quality of color almost equal to daylight, under which condition it has become possible to do practically any work under artificial illumination, and it has become possible, instead of being limited to six or eight hours close work during the day, to extend the time of close work to ten or twelve hours. The result is necessary and obvious—that the strain on the eye during the long continued work is greater than can be recuperated from during the period of rest, and as a natural conclusion we must expect that affections of the eye become more frequent, resulting from the possibility of extending the hours of work, the possibility of working longer under artificial illumination, but this not a fault of the artificial light. Even if the artificial light were identical with daylight, were daylight indeed, the mere fact of straining the eye for a greater length of time would give practically the same effect, so that we see the result has been attributed chiefly to decidedly erroneous causes, the character of the artificial light, while it was, in most cases, not the character of the artificial light, but the duration of time of using the artificial light, that is the abuse of the eyes by too long continued strain.

However, there are undoubtedly certain harmful effects inherent in artificial light. There are harmful effects, also, in daylight, when used improperly, but the latter is not the topic of our discussion, we are discussing only artificial light here.

Artificial light can be made very harmful by improper illuminating engineering, or the absence of all illuminating engineering; too high or too low intensity; location of the light sources in the field of vision and in general excessive intrinsic brilliancy—and unfortunately some of the most modern illuminants are almost criminally offensive in this respect; improper proportion between directed and diffused light; improper direction of directed light; improper density, location and termination of shadows, etc., are all causes of unsatisfactory, that is, harmful illumination.

Assuming, however, that all these defects—which are a frequent source of eye troubles—are absent, and proper illuminating engineering has been used in the installation of the lighting systems, there still remains the possibility of some harmful effects, and these form the subject of the following discussion.

These harmful effects can be grouped into three classes: The indirect effect, due to the impairment of distinction by the color of the artificial light; the direct effect of the power of radiation, and then, third, the specific effect of certain frequencies of radiation.

As regards the indirect effect, we know that in artificial light, the light of the incandescent lamp for instance, we cannot match colors. With the incandescent light the white and yellow and brown and red shades are less distinct from each other than in daylight, so, also, the blue and violet and black shades are less distinct from each other. Similar effects we get in other colors from other illuminants. In the bluish-green light of the mercury lamp, red and black become similar, and green and white vanish into one color.

Light is used for seeing objects, and the distinction of objects is based either on the distinguishing feature of differences in intensity or of differences in color; in short, we see the objects by intensity differences or by color differences. Any colored light discriminates against two colors, the excess color and the deficient color; the excess color fades into white, the deficient color into black, and in colored light, therefore, certain color differences are very greatly reduced. We lose, as the result thereof, in distinction, as far as it is based on color differences of this character, and to see such color differences, the eye is strained to a greater extent than in daylight, when distinctiveness of colors is greater. If we desire to assort or separate different shades of white and yellow and brown and red, under the incandescent lamp, it imposes a much greater strain on the eye than to do this by daylight, because the differences are much less distinct, and that means, necessarily, that it is harmful to the eye by overstrain. For other purposes, again, where we desire to distinguish, for instance, blue and white, the incandescent lamp may have an advantage over daylight, because these distinctions become greater. So we find that for some purposes, some distinctions of color, the incandescent light may be actually superior to white daylight. For many purposes, however, it is inferior, and therein lies the disadvantage and resultant harm of colored light for the distinction of objects. It reduces one set of distinguishing elements, color distinctions between white and the excess color of the illuminant, and between black and the deficient color of the illuminant. For some purposes, therefore, the mercury arc lamp, with bluish-green light, is superior to the incandescent lamp for bringing some color differences out more sharply. Again, for other purposes, as in machine-shop work, where brass and copper is handled, the mercury lamp would have a disadvantage, because the difference in appearance between brass and copper is reduced in the greenish light of the mercury lamp, this distinction made less sharp and therefore it is harder on the eyes, to distinguish the two substances from each other. We have here an indirect effect of colored light, an impairment of certain color distinctions, which may be harmful by the strain it puts on the eye, in those cases where these color differences are essential for seeing by. It is the field of the illuminating engineer to choose as far as possible that color tinge of the light which is best suited for the particular purpose for which the light is used, to bring out those distinctions most sharply, and not obliterate them. Where we do not know what the light will be used for, or where its use will be a general one, all we can do, naturally, is to choose a white light, as nearly daylight as possible, because it does not discriminate against any color. This incidentally also explains that the use of blue or amethyst colored glasses has been found to be beneficial in relieving the strain on the eye under the incandescent light. By blinding off a part of the excess color, while the eye really received less light, the color differences which cause the distinction may actually be increased, and thereby the seeing made easier and clearer.

This effect can hardly be blamed to the light or its color, but is an effect resulting from the particular use to which the light is put, and you cannot say that yellow light is inferior to green light, or that green light is inferior to yellow light, and so on, but any color of light may have advantages in some cases, and disadvantages in other cases, and even white light may be inferior to colored light in some cases of color distinction, and certain colored lights superior, as the blue-greenish mercury vapor light shows a better distinction between slightly dirty and clean fabrics than the white light shows. In general, however, this effect is pointing to that direction to which modern illuminating engineering trends, that the white light is the most desirable, the nearest approach to daylight, and as you know, we are getting nearer to it—the incandescent lamp is whiter than the gas flame or the kerosene flame, the tungsten lamp whiter than the incandescent carbon lamp, but even the tungsten lamp is still decidedly yellow.

The second harmful effect of radiation is the direct power effect. Radiation is power, and as such, when entering the eye, is absorbed, that is, converted into heat, and when of an excessive intensity becomes harmful. In the eye we have a protective mechanism guarding against the entrance of excess light. For sudden excess light the eye-lids close automatically. Moderate excess light causes the pupil to contract, and therefore, to reduce the amount of light which enters the eye. However, this protective mechanism does not afford complete protection. The contraction of the pupil reduces the entrance of light to an amount which is not rapidly harmful, but still admits a sufficient amount of light to become harmful when the eye is exposed to it for long time, for instance, when tending a furnace as fireman, or in a similar capacity. We find that sufficient power of radiation enters the eye to cause after some time harmful effects, inflammation.

The protective mechanism closing the eye-lids, while quick, is not instantaneous and a very sudden excess intensity is not guarded against, as for instance, the flash of an explosion or a short circuiting arc of an electric system; before the eyelid can close sufficient power has entered the eye to cause harm, to cause what may be called a *power burn*, because the nature of the harm done is of the character of a burn. You see, then, we may get harmful effects by the direct power of radiation, if excessive, either acute, when we are exposed to excessive intensity of light momentarily, as in the case of an explosion or a short circuit, or more slowly, if working continuously under conditions where we are exposed to high intensity of light, as at an electric furnace, for instance. The affection resulting herefrom, "power burn," gives a certain definite set of symptoms. Where it is acute, as in the case of exposure to an explosion or a short circuit, the effect appears instantaneously, or immediately after exposure, in the form of temporary blindness, followed by effects of the nature of an inflammatory affection. In this case of power burn, the external effects are very pronounced and marked, they appear formidable, redness, swelling, tears, acute pains, but the characteristic is that recovery is also very rapid and practically complete—even in the case of quite a severe power burn recovery usually results in a few days, so that the effect is more serious looking than actually harmful, although, naturally, it is not advisable to look at a short circuit, if you can help it.

In the case of a chronic power burn, where the eyes are inflamed by looking into a fire too often, or working too long under too high an illumination, etc., as soon as the patient gives up the occupation which exposed his eyes to excess radiation power, and takes care of his eyes, the effects very rapidly disappear and complete recovery ensues, except where permanent structural changes have already taken place in the eyes, which is not very likely to be the case.

* Read before the Engineers' Club of Philadelphia.

In causing a power burn, most artificial illumination is decidedly more harmful than daylight. Most artificial illuminants derive their light from temperature radiation, that is, the light is given by high temperature of the radiator, by incandescence, from filaments, or the incandescent carbon particles in the flame, or the incandescent carbon tip of the arc lamp. Of the total radiation in these cases, an extremely small fraction is visible, most of it is invisible ultra red radiation power. The amount of power, therefore, which enters the eye from an incandescent lamp, or a similar source of light, is very many times greater than the amount of power which enters the eye together with, or as the result of, the same intensity of illumination from daylight; that is, to get the same amount of visible radiation into the eye, we get very many times more power from an incandescent radiator and herein lies the greater harmfulness of incandescent radiation; in other words, of most artificial illuminants. It is not only the light which causes the trouble, but the invisible ultra red radiation power, which we get with the light, which does the harm.

You see then, that increase in the efficiency of the illuminant means reduction in the total radiation power, reduction of the heat which we take in in addition to the light. If the efficiency of the incandescent lamp is raised from 4-watts per candle to 2-watts per candle, that means for the same amount of light which enters the eye there is only half as much power, and the light is only one-half as harmful. Those illuminants which are not based on temperature radiation, but on selective radiation or luminescence, usually have a much larger percentage of visible radiation, among the total radiation, and therefore are less harmful. Thus the light of the Welsbach mantle is much less harmful than the light from a kerosene lamp, because, with the same amount of light, the total radiation power is very much less. So the light of the mercury lamp is very much less harmful than that of the tungsten lamp, and the tungsten lamp is less harmful than the carbon incandescent lamp. It is merely a question of the radiation power with which we have to deal, and which, as power, if it is large, does the harm.

An instrument which indicates roughly the power of radiation is Crookes's radiometer. It is a most convenient way of ascertaining how much heat accompanies the light given by any light source. You will note the radiometer, which hardly moves in daylight, will spin rapidly around at the same intensity of artificial illumination, incandescent light or gas light. Again, in the light of the mercury lamp, it stops as there is very little power back of it. This is a very rough indication, but it is useful, as it shows whether we have to do with a considerable amount of power, and the entrance of the radiation power to the eye may be harmful or annoying, or not.

In addition to the effect of radiation power in the eye, the power burn, there is a specific effect of certain wave lengths of radiation, mainly the ultra-violet light. This effect is still absent in the green light, possibly begins to a very slight extent in the blue and violet, and increases in the ultra-violet, reaching a maximum at the extreme end of the ultra-violet, and persists, possibly reduced in intensity, up to the X-rays. This specific action is a harmful action—it causes what may be called an *ultra-violet burn*. It is so called, because it is most pronounced with ultra-violet light. When discussing ultra-violet light, however, we have to realize that ultra-violet light is not one special kind of radiation, as green light, or yellow light, and very much of the literature on the effect of ultra-violet light is, therefore, misleading or useless because it merely speaks of ultra-violet light as one kind of light. We must realize that the range of ultra-violet radiation extends over more than twice the range of the visible light; that is, the range from the longest ultra-violet waves to the shortest ultra-violet waves is about two octaves, while the entire range of visible light, from the red to the violet, is less than one octave.

We have discussed and know the different physiological effects of orange-yellow light and bluish-green light, and know there are many pronounced differences between these two kinds of visible light. These two kinds of visible light are less than half an octave distant from each other, that is, their difference is less than one-quarter the difference between the two ends of the ultra-violet rays. Thus you see we cannot speak of the effect of the ultra-violet light in general, but we must discriminate between the different wave lengths of ultra-violet light.

We may most conveniently consider three sections of the ultra-violet spectrum, the long *ultra-violet waves*, that is, ultra-violet light from the visible violet radiations, to a quarter or possibly a half octave into the ultra-violet, that is the lowest frequencies or longest waves of ultra-violet light. Beyond this we get what we may call the moderate or medium frequency, or *medium wave lengths of ultra-violet light*, half an octave or so beyond the visible, and then the *high frequency ultra-violet waves*, the shortest ultra-violet waves, from one to two octaves beyond the visible.

These three parts have very different effects. The low frequency ultra-violet light is practically harmless. If of very excessive intensity, it may cause, and does cause, ultra-violet burns, but if of moderate intensity, the form in which it exists in daylight, it is harmless, and in that still more moderate intensity, in which it exists in artificial illuminants, it is still more harmless. Harmful effects, however, exist in the medium wave lengths, in the ultra-violet light about one-half octave or three-quarters of an octave beyond the visible. This medium high frequency ultra-violet light is very decidedly harmful to the eye. It causes, even at moderate intensity, a very severe affection of the eye. When you come to the high frequency ultra-violet waves, they are destructive to the eyesight. Exposure to a moderate intensity for a few minutes only, results in very severe affections from which recovery is very slow, and in some cases has not yet occurred completely after eight years since the harm was done. So you see the danger of ultra-violet light increases very greatly when we come to these higher frequencies or shorter wave lengths.

The "ultra-violet burn," in its symptoms, is distinctly different from the "power burn." As we have discussed, in the power burn, the affection due to excessive power of radiation, the effect is immediate after the exposure, and the external effects are very pronounced, are very bad looking, but recovery is rapid and complete. In the ultra-violet burn the first effect appears a considerable time after exposure, from six to eighteen hours after exposure to ultra-violet light, up to weeks after exposure to X-rays. The external appearance of the inflammation is very insignificant, frequently absent, but the effect is extremely lasting, even in mild cases for weeks, and in more severe cases for years, if complete recovery ever occurs.

In chronic cases, in continued or frequent exposure to ultra-violet light of moderate intensity, as, for instance, when working around open arcs, that is arcs not protected by glass globes, around spark discharges, as at the sender of the wireless telegraph station, an ultra-violet burn appears as a chronic affection, and the two characteristic symptoms are a characteristic headache, occurring with increasing frequency, and what may be called a blurring of the vision. That is, the first effect generally is that of headache, occurring with increasing frequency, which may be characterized either as headache, or as eyeache, a deep seated pain back of the eye. It is very frequently for a long time not assigned to its real cause, because there is usually some temporary reason, some slight indigestion or so, which brings it about, until the increasing frequency of the occurrence and the severity of the symptoms leads ultimately to a suspicion of the real cause, the exposure to the ultra-violet light. The second effect is a blurring of the vision, that is, in such cases you may see clearly, the eyes are perfectly able to focus, but you cannot keep anything in focus for any length of time. After you start reading, in a short time in the case of a severe burn, the letters begin to blur and run into each other, particularly if you attempt to read in a street car—this is usually one of the first symptoms, that you cannot comfortably read your paper in the street car any more, because you cannot keep your print focused. These two symptoms, headache and blurring of vision, occur with increasing severity and frequency until the patient is obliged to give up the occupation which caused the ultra-violet burn, and then very slowly recovery occurs, but there remains, even after many years, a specific sensitivity to high frequency light, even such light which is harmless to the normal eye, as the green mercury light. Such light appears disagreeable and produces a recurrence of the symptoms, more or less severely.

I have discussed the symptoms of ultra-violet burn somewhat fully, because while ultra-violet light has been blamed largely and unjustly for much of the trouble with eyesight, at the same time we must realize that with the development of the industry, the chances of exposure to ultra-violet light are increasing and the affection of the eye resulting from it is usually so severe and lasting, and so annoying, that it is very desirable to notice the first symptoms and avoid the cause.

As to temperature radiation, even at the highest temperature, the tungsten lamp and the crater of the carbon arc, it does not contain any appreciable amount of ultra-violet light, so it is entirely harmless in this respect. The arcs give a considerable amount of ultra-violet light, least the plain carbon arc; from the carbon arc the amount of ultra-violet light is so small that carbon arcs can safely be used without glass globes, and as you know, have been used for street lighting and are still used so. It would undoubtedly be harmful, on account of the ultra-violet burns, if one was exposed to the open carbon arc at short distances for a long time, but at the relatively low intensity at which it is used for street lighting, it is harmless.

In the case of flame arcs and luminous arcs, it is not safe, even for a short time, to be exposed to the light of the flame arc or luminous arc, when it is not enclosed by a glass globe, and any experimenter who has anything to do with them must be cautioned to be sure that he has a glass globe around the arc, otherwise when he works with the exposed arc for a few hours he may have some weeks' time to think over how foolish he was. The ultra-violet light of the flame arc and luminous arc extends only to medium high frequencies, and the very high frequencies have so far only been observed in the light of the low temperature mercury arc. Since glass is entirely opaque to these high frequencies, a mercury arc inclosed in a glass tube is harmless, because while the high frequency waves are produced inside, they cannot penetrate through the glass. In the quartz tube you get these extremely high frequency radiations. You get them, however, only in the low temperature mercury arc, and they do not seem to appear to any great extent in the rays from the commercial quartz lamp, where the arc exists in a quartz tube at high temperature and high pressure. In the case of the mercury arc, the mean average frequency of radiation decreases with increasing temperature; with increasing temperature, there is a change from high to low frequency, from short to long waves, the opposite to temperature radiation. The long wave lines increase with increasing temperature more than the lines of short wave lengths. Inversely, in the iron arc the ultra-violet radiation increases with increasing temperature faster than the visible radiation, and the arc changes with increasing temperature from white light to the non-luminous ultra-violet radiation at excess temperature, while the mercury arc changes from green, at low temperature, to white and ultimately to red at very high temperature. These changes are characteristic of the luminescing element, but follow no general law.

(To be concluded.)

RUBBER PLANTS ON THE IVORY COAST.

In the high-lying forests of the Ivory Coast, says a writer in Die Gummi-Industrie, the *Kicksia elastica* is found in great quantities, although only at a distance of at least thirty-six miles from the sea. The caoutchouc is won in many districts from the trees which have been felled. The stumps put forth new growth; although often this dies later in the shade.

In many districts the trees are incised crosswise; they die however, as a rule, after the second tapping, and then dry up without putting forth new shoots. But they are replaced, in the plantations which the natives have abandoned, by numerous Kicksia trees which grow from seeds carried thither by the wind.

The Kicksia rubber comes to market under the name "lumps d'Abiviso" and "Hard Cakes de la Côte ouest," but is considered as of inferior quality, principally because of the admixture of other and poorer kinds of rubber therewith.

Ficus vogelii, in contrast to the *Kicksia*, is found right on the coast, and for a distance of about eighteen miles therefrom, in marshy ground. The total of the rubber therefrom is about 25 tons per year. There are two kinds: one a small tree, the other epiphytic. The latter yields a better grade of rubber, and more of it, than the tree variety.

In order to get rubber from the epiphytic variety, the plants, together with the tree on which they grow, are cut down to the very roots and tapped by deep, almost ring-shaped cuts, about a foot from each other.

The milk that is collected is allowed to stand a few days, in order to coagulate. This rubber is considered as of low grade, although the amounts thereof are considerable. From one tree there are sometimes won 22 pounds of rubber; and from one of the epiphytic plants 5 gallons of milk.

Of the liana varieties of rubber plants *Landolphia ovariensis* yields the best gum. In order to win it, the liana or climbing plants are as far as possible pulled out from the ground and then cut in lengths of about 6 to 8 inches each, and the rubber which exudes from the cuts collected. From the stumps which remain in the ground, new vines grow. Specially thick vines which cannot be pulled up by the roots are tapped by crosswise cuts.

Good rubber is also yielded by *Clitandra elstica*. The milk of the liana is, however, difficult to coagulate. This is best done by letting it, after diluting it with water, slowly simmer for a long time; the precipitated rubber is removed and kneaded together with the hands.

The other kinds of plants that yield rubber seem hardly to be suited for exploitation. Among these may be mentioned *Carpodinus hirsuta*, which exists in great quantities, and is used in adulterating the Kicksia rubber.

THE GREAT RIVER OF THE NORTHWEST.

A STREAM WITH A FUTURE.

BY KATHERINE LOUISE SMITH.

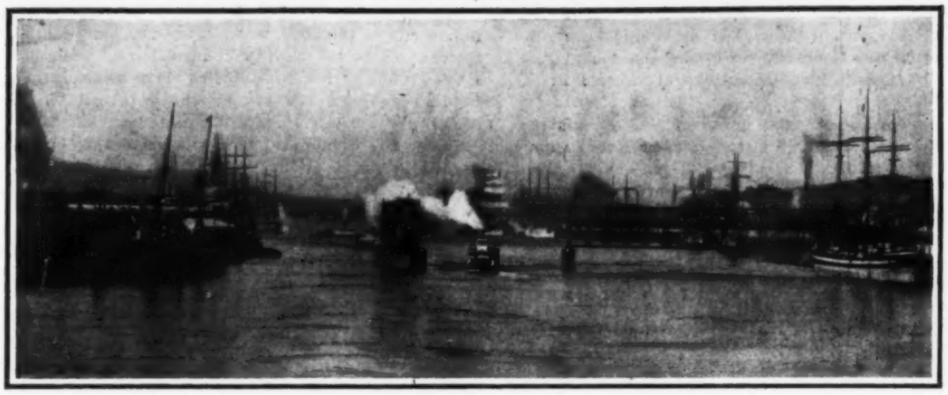
In these bustling days it is difficult to approach the mighty Columbia, especially where it flows into the Pacific, without indulging in historical comparisons. The tales of romance with which a hundred or more years ago are englamored are so intermingled with the prosaic to-day that it takes time to adjust one's thoughts and to sweep from the mental picture such valiant personages as *couriers du bois* and Spanish, English, and American *voyageurs*. What tales of adventure this great Northwest could tell of this mighty waterway as it passes through lakes and ravines, twice crossing the international boundary, to at last gently nestle in the bosom of the Pacific. Nature has been generous and capricious with this history-making river. There are hill-surrounded stretches that bring to mind the lochs of Scotland; there are ribbon-like threads of blue that wind through black obsidian lava which suggest the Infernd; there are many cliffs of onyx-like basalt, immense terraced palisades, towering toward heaven and cleft by dashing, foaming waterfalls. Hundreds of miles to the north there are snow-clad mountains contributing tiny streams that join to make this river rush madly to the lower level lands and the sea.

It was in October, 1805, that travel stained and weary, those doughty explorers Lewis and Clark reached the magnificent Columbia River at the "Great Falls," now known as Celilo. This was the first approach from the east of which we have any record. Capt. Robert Gray of Boston, in 1792, had already discovered the tremendous stream as he sailed along the Pacific coast. He crossed the bar at the mouth and sailed upstream some fifteen or twenty miles. Others had seen the pouring of this river into the Pacific, and Spanish maps had shown it for some years, but Gray entered it, gave it the name of Columbia after his noble ship, and to him really belongs the credit of its discovery. In scenic effects the river has remained unchanged since the explorer named it, and its palisades are unsurpassed by those of the Hudson, the Mississippi, or any American waterway. In early times its shores were the home

SUNRISE ON THE COLUMBIA RIVER.

COLUMBIA RIVER NEAR THE DALLES—AN EMERALD STREAM BETWEEN BLACK WALLS.

THE GREAT RIVER OF THE NORTHWEST.



HARBOR AT PORTLAND, OREGON.

of Indians, who paddled in canoes to the ocean; today it is a vast commercial thoroughfare, along whose banks railroad trains rush, and thriving towns now take the place of Indian villages.

"Where rolls the Oregon." How came this name? A hundred reasons are given. Capt. Jonathan Carver, the explorer, calls it the Oregon, and so many times has it been referred to in that way that investigators have decided it comes from the Spanish *Aragon*, a name given to the whole of the Northwest by the Spaniards. Oregon or Columbia, it is a tremendous waterway, indelibly associated with the making of the Pacific coast. In places, near its mouth, it is fifteen miles wide; over twelve hundred miles long, it drains a basin approaching five hundred thousand square miles. British Columbia, Oregon, Washington, Idaho, Montana, Wyoming, Utah, Nevada, make a long list of geographical divisions associated with the Columbia, and it is safe to say that no one embarks on its waters for the first time without being overwhelmed with its grandeur.

Though the Columbia presents unforgetable phases of wild nature in the Kootenays, and as it winds between Oregon and Washington, this aspect of the river belongs largely to those who are broad enough to enjoy revised geography; and the usual journey is from Portland to the Pacific, where it enters near that vast headland Cape Disappointment—the San Roque of Spanish days—and east as far as the Dalles. Strange to say, Portland is not on the vast river, but on its tributary, the Willamette, and twelve miles of this stream must be passed before one enters on the broad bosom of the Columbia with its one million six hundred thousand cubic feet of water every second. To really enjoy the Columbia in a short time, one should spend a day in going to Astoria and take another day to go up the river, returning either by boat or rail. The historian will take the journey to the ocean, to follow the course made memorable by early navigators, the winter camp of Lewis and Clark, and the fur-trading expeditions by the agents of John Jacob Astor, who established Astoria in 1811, where it now stands.

Portland harbor is an interesting cosmopolitan study, for it accommodates large deep-water vessels. It presents a kaleidoscopic appearance with ocean

ONEONTA GORGE, COLUMBIA RIVER.

MULTNOMAH FALLS, IN TWO LEAPS

THE GREAT RIVER OF THE NORTHWEST.

craft from China, Japan, Honolulu, Alaska, and Pacific ports. British, French, German, Russian, Italian, and Danish boats seek refuge here, and the Columbia River steamboat swings quickly past, through the widening river, in front of the government lighthouse, and round a sharp bend. Suddenly, without warning, the snow-capped peaks of Mt. Hood, Mt. Adams, Mt. St. Helens, Mt. Ranier, and Mt. Jefferson burst on the view. They are the glories of the Columbia coast, yet there are those who have crossed a continent to see them and returned without a glimpse. Fog and forest fires are sometimes hostile to these mountain splendors, but they never hide the hillside farms and coolies, fishing flats, salmon canneries, and sawmills —the prosaic evidences of the river's industries. In early days the bar at the river's mouth was a serious obstacle to vessels, but the channel has been altered, and many of the difficulties of navigation through this portion have been overcome.

Unless one has seen the Pacific it is well to take this short journey to Astoria, Fort Canby, Cape Disappointment, and the lighthouse and to the numerous seaside resorts with their excellent hard beaches, oyster beds, and glimpses of seals disporting on the rocks. Fort Canby gratifies the desire to see a modern fort, for it is equipped with the latest seacoast armament and stands near the site of the Chinook village mentioned in Irving's "Astoria." The view from Cape Disappointment lighthouse, over the bar, is magnificent in its broad sweep. Far out to sea the lightship can be dimly seen, and close at hand the Pacific madly foaming dashes its spray high toward the lighthouse tower.

The Oregon side of the beach is low, and the government has expended over two million dollars in building a jetty five miles long. On the Washington side the country is hilly, but the coast is so well supplied with lighthouses that twenty miles out at sea the mariner can watch the welcome gleam. This is the harbor where McDougall and other emissaries of John Jacob Astor landed after doubling Cape Horn in the "Tonquin," and were welcomed at the "entrada de Hecata" of Spanish maps by the chief of the Chinooks. Here they cut down trees, leveled thickets, and erected a residence, stone house, and powder magazine, which in honor of the promoter of their enterprise they called Astoria. It was a perilous undertaking, even for such doughty men as Astor's associates, and many disasters befell the small company at the trading post.

Though the Columbia River toward the mouth is associated with history, everyone will agree that the Upper Columbia ranks first in beauty of scenery. Its wild, inspiring grandeur cannot be duplicated among our rivers, though it may lack the barricaded castles of the Rhine and the lordly estates of the Hudson. The rough, savage cliffs, beetling crags, and great headlands overwhelm with their stupendous proportions. A succession of surprises continues for the one hundred and seventy-five miles to the Dalles. It is unconventionalized nature, tremendous in its setting and resonant in the call of its titanic forms, the heads of whose forest-covered pinnacles, rocky headlands, and nearby mountain peaks are buried in the clouds.

At the entrance of the gorge of the Columbia is Table Rock, which has a sister, Rooster Rock, a huge basaltic projection which stands in bold relief against the shadows of the hills. These are forerunners of other rocky promontories, down whose sides beautiful waterfalls trickle, and cataracts from the slopes above rush with riotous confusion into the river below. These cascades, which spring from many crevices, and often from a mountain top, are vivid notes in the Columbia River's symphony. Some are so small that they need a glass to detect them, others glisten like snow wreaths, and twist down the mountain's sides or spread out through groups of evergreen to drop like a fleecy veil of mist.

Cape Horn, a huge projection with a vertical face, affords the most inspiring scene on the river. It consists of towering pillars of rock from five hundred to two thousand feet high. These, lashed by stormy waters at their base, form a cape covered with green grass and trees on the slopes above and present many contrasts.

It is a relief after these gigantic basaltic cliffs to greet the waterfalls and cataracts, the grandest of which, Multnomah, drops eight hundred and fifty feet in two parts. Bridal Veil, Laturelle, and Horse Tail are other falls not far from Castle Rock, which Lewis and Clark selected for a landmark because here they first noticed the swell of the tide. Thirteen miles square is this huge boulder, which was never scaled until 1901. It precedes the mountains on which are the abutments of the "Bridge of the Gods." From the abutments on one side of the river and the traces of trees far below the surface of the water, the white man has concluded that the Indians are right in saying that at one time the Columbia River was spanned by a natural bridge under which the water flowed.

That some upheaval once took place is evidenced by the rolling and tossing of a steamer as it plunges down through the Cascades and into the three million dollar locks before it reaches the Middle Columbia. Points of interest come rapidly between here and the Dalles. The giants of the forest which are seen in Oregon stand out on mountain slopes in contrast to the crystalline waters below. In the distance snow-white domes which gradually fade from view, as lonely and still hills draw nearer the water's edge. From here to the Dalles, along the Middle Columbia, the river seems a great land-locked lake of inspiring beauty. Little landings appear, the small town of Mt. Hood, famous for strawberries and apples, and trails to springs inland to which Indians from all over the West brought their sick, formerly crossing the Bridge of the Gods to reach them.

Suddenly a lonely island appears—Memaloose—the Indian city of the dead, where from time immemorable the Indians of the Northwest have buried their dead above ground in low boxes which serve as tombstones. Lewis and Clark saw some grinning skulls on this island, and for many years it was never visited.

So far the Columbia has shown its beauteous side, its adaptation to civilization, its fish wheels and salmon industry, its high cliffs, and placid farmland. Farther on it becomes unnavigable for many miles, and here the most wonderful part of the stream is seen. Through and over basaltic formations, black as coal, bare of vegetation, runs a sinuous ribbon of blue, the color intensified by the darkness of its banks. For miles around the deathlike escarpment stretches with no trace of color save an occasional sand dune and the living stream on its way to the ocean. Through these black Erebus-like walls runs the immense body of water until it makes a succession of falls, the largest, Celilo, thirty feet high. Strange, terrible, awesome is the scene, yet in the midst of this desolation are Indian wigwams on the river's brim. The occupants live on the rich and fertile country beyond.

Photography can do little justice to this majestic river, which drains five hundred thousand square miles. It presents strange, uncanny aspects and moss-covered banks, a contrast from bleak despair to rare fertility. Its commercial side is another story. When Lewis and Clark discovered the mouth of this stream, they entered in their diaries that here was a pink fish, which especially delighted them. The fish seines are always curious, and the big fish wheels which revolve slowly, moved by the current, scoop up thousands of salmon. Another novelty to strangers is the men and horses breasting the current and drawing in the nets that have been left over night. Many a fine chinook is caught in this way and sent to the cannery, where it is skinned, cleaned, cut into pieces, put in cans, and steamed. Some time this mighty river will have other industries, but nothing can take from it the towering cliffs and diversified aspects as it runs from its Canadian source to the sea.

MEMALOOSE ISLAND: THE INDIAN CITY OF THE DEAD.

THE GREAT RIVER OF THE NORTHWEST.

At Frankfort, states the Electrical Review, one of the phases of the three-phase network has been earthed at the generating station through a water column of 2 ohms resistance, with the result that pressure surges have been greatly diminished in frequency. The danger of leakage to earth in the network is reduced by one-third, and when a fault occurs on one of the insulated lines, the circuit-breakers are opened at once. Switches are required only on the insulated conductors. In the case of overhead lines, the earthed conductor is carried on the top of the poles on low-pressure insulators, and is protected at intervals by low-pressure lightning arresters, thus reducing the cost of installation. The results of the system are regarded as very favorable.

TO THE POLE BY AIRSHIP.

POLAR EXPLORATION ACCORDING TO ZEPPELIN.

BY DR. BRUNO SERGERT.

The most obvious method of seeking the North Pole is to sail due north from Norway, for in this region the sea is freed from ice to about 80 deg. north latitude, nearly every summer, by the influence of the Gulf Stream The pole is only 700 miles farther north, but the way is blocked by pack ice, through which Peary found it impossible to force a passage. Other explorers have been equally unsuccessful. The Austro-Hungarian expedition which discovered Franz Josef's Land experienced great difficulty in reaching that point, and was compelled to finish its journey by sledge.

The ill-fated "Jeannette," which attacked the pole from the western side, starting from Behring Strait in 1879, was soon frozen in and thereafter drifted helplessly with the ice until it was wrecked north of eastern Siberia, in 1882. Three years later objects unquestionably belonging to the expedition were found on the west coast of Greenland. This discovery, and the occurrence, on the same coast, of large quantities of driftwood of eastern Siberian origin, prove the existence of a current flowing from Behring Strait or eastern Siberia, over or near the pole, to Greenland.

On this current Nansen based his expedition of 1893-1896. His plan was to sail along the Siberian coast as far east as possible, and then turn northward and drift along this current with the ice pack. The "Fram," however, drifted far south of the pole and even with sledges Nansen got little beyond the 86th parallel. The expedition, however, confirmed the existence of a current which alone would prevent a ship, starting north from Norway, from reaching the pole. Amundsen is now fitting out an expedition with the intention of drifting with the current from a point north of Behring Strait.

Peary's sledge journey to the pole has little scientific interest, because it is impossible, in such conditions, to carry much apparatus or make observations of great value.

In 1909, when the dirigible airship had been so far perfected that it accomplished very long journeys, though not without numerous accidents, the idea of employing the new vessel in scientific polar exploration naturally occurred to Count Zeppelin and his associates. The steady progress which the airship was making held out the hope that its many minor defects would soon be remedied by diligent labor and experiment. Then was formed the plan of taking an airship to Spitzbergen, the most northerly point that can conveniently be reached by sea every year, and thence undertaking flights in the Arctic region, if not directly to the pole.

A Zeppelin airship, if absolutely reliable in operation, would be the ideal vessel for Arctic exploration. It would escape the almost infinite difficulties which attend the progress of a ship through polar ice, and it would be capable, as has already been proved, of carrying an extensive collection of apparatus for scientific research. The distance from Spitzbergen to the pole is about 700 miles, and the journey to the pole and back might, very probably, be accomplished in a single season. But the attainment of the pole is not the main object of an Arctic expedition undertaken for the advancement of science. The survey and exploration of the uncharted land masses between Spitzbergen and Franz Josef's Land would possess great interest for geographers.

For the purpose of determining the possibility of making extensive journeys in these regions with a Zeppelin airship, an experimental expedition was fitted out last summer. The expedition was commanded by Prince Henry of Prussia and included a number of eminent men of science, in addition to Count Zeppelin. The vessels employed by the explorers were the North German Lloyd steamer "Mainz" and the small Norwegian wooden steamer "Phœnix," constructed especially for ice breaking, which was added for the purpose of pushing forward through ice too heavy to be attacked directly by the great iron vessel with its barely submerged twin screws. The special object of the expedition was to study the general topography of the region and the conditions of wind and weather which determine the character of the aerial ocean in which the airship must travel.

The most important data for aeronautic purposes are the direction and force of the wind. The simplest method of obtaining these data for various heights above sea level is based on the employment of pilot balloons. India rubber balloons, of a capacity of 10 to 20 cubic feet, are filled with hydrogen, and set free. It has been proved by experiment that, in these conditions, the balloon ascends with a constant velocity, which depends upon the initial buoyancy. If the balloon is constructed to ascend 200 meters per minute, we know that it will attain an elevation of 1,000 meters in five minutes. If we follow the flight of the balloon with theodolite mounted at the place of ascent, and from time to time note its angular altitude and direction we can determine the horizontal distance which it has traveled at each of the instants of observation by multiplying the height to which it has ascended by the cotangent of the angle of elevation, or altitude. (The height to which the balloon has ascended is obtained by multiplying its known velocity of ascent by the time which has elapsed since it started.) By this method it is easy to determine the horizontal distance traveled by the balloon in any one minute, and, consequently, the velocity of the wind at the elevation at which the balloon is then floating. Pilot balloons were employed in this way as often as the general programme of the expedition permitted.

A better knowledge of the meteorological conditions of the upper atmospheric strata can be obtained by means of small captive balloons which, however, can be employed only in a calm or a very light wind. The balloon has a capacity of about 175 cubic feet and, consequently, when filled with hydrogen, is able to carry about 11 pounds in addition to the weight of the India rubber gas bag and its netting. A small apparatus which comprises a barograph, a thermograph and a hygrograph, or humidity register, is suspended from the netting. The three instruments inscribe their records on smoked paper stretched over the head of a little drum which is rotated by clockwork. The balloon is attached to the end of a coil of piano wire, which is paid out and hauled in by a winch. The elevation which the balloon has attained at any moment of its flight can be deduced from the curve of the barograph, while the thermograph and the hygrograph give the temperature and humidity of the air at that height.

The record of humidity is especially valuable for determining the height of fog. As fog is formed only where the air is saturated with moisture the hygrometer records a very high degree of humidity throughout the layer of fog and much lower humidity above and below that stratum. The determination of the height and thickness of fog banks is very important in aeronautics.

In even a moderately strong wind the captive balloon is useless, as it would be blown down to the ground. In this case an ingenious expedient is employed. Two balloons, each of 175 cubic feet capacity, are attached to two cords, each 50 meters, or 165 feet, long, and the ends of the cords are fastened together. The triple instrument described above is attached to the junction of these cords, and from it a hollow float is suspended by a third cord of the same length. The balloons, with the attached instrument and float, are then set free. They ascend until one of the balloons burst. (The chance of both bursting at once is infinitesimal.) The remaining balloon is then dragged down by the weight of the instrument and float until the float strikes the water. The skill of the experimenter is exhibited in adjusting the weights of the instrument and float to the buoyancy of the balloons so that, when the float is supported by the water, the remaining balloon is able to keep the instrument in the air. Meanwhile the drifting balloons have been followed by the ship, so that the instrument and the record it has made can be picked up.

The expedition carried also a captive balloon of 17,500 cubic feet capacity, which, when inflated with hydrogen, was capable of carrying three men. It was moored by a steel wire rope, operated by the steam winch of the "Phœnix." This balloon proved exceedingly useful for giving a view of the surrounding land, water, and ice. Ascents were made from a small island in King's Bay and from the ice pack north of Spitzbergen, where it was necessary to anchor the balloon to the ice.

The result of all these experiments was as follows: During the thirty-three days which the expedition passed at Spitzbergen there were only three days in which a Zeppelin airship would probably have been unable to make an ascent. As a rule the wind was so light that a start could have been made without the slightest danger, and even on the three days specified high winds were not general, but strictly local. For example, an ascent was made with the large observation balloon from the "Phœnix" in the ice pack while the wind was too strong a few miles away in Magdalen Bay, where the "Mainz" lay, to allow the use of a small recording captive balloon. In regard to fog, the records of the instruments showed that the depth of the fog bank never exceeded 650 feet, and that its upper limit was never higher than 1,000 feet, so that an airship could easily have sailed over it. In Spitzbergen fog appears to be caused only by the cooling of the air by glaciers and pack ice, the influence of which does not extend to a great height. Aerial travel in the Arctic is favored also by the fact that the diurnal variation of temperature is exceedingly small in summer, as the sun is always at nearly the same altitude above the horizon.

Another problem which the expedition undertook to solve was that of anchoring an airship when the journey is interrupted by the necessity of making scientific observations and explorations on land, by a breakdown of the motor, or by any other cause. Especial attention was given to the possibility and the best method of securing anchorage in ice. Experiments were made with ice anchors inserted in holes drilled in the ice with specially devised boring tools. As the expedition was not provided with a large airship the pull was exerted upon the anchors by means of steel hawsers, which passed over levers to the steam winches of the ships. The anchors held surprisingly well, and the feasibility of securely anchoring an airship in this way was fully demonstrated.

In order to bore the holes for the anchors, however, at least one man must leave the airship. The increase in buoyancy thus produced must be counteracted either by holding the airship down by means of its propellers or by the temporary employment of trailing anchors, such as are used by whalers in the ice.

The results of the expedition sustain the opinion previously held by its leaders, that aerial navigation is at least as practicable and as safe in the vicinity of Spitzbergen as it is in Europe, and possibly more so, because of the favorable conditions of wind and weather. An absolutely trustworthy motor still remains to be found, and to the search for it the attention of Count Zeppelin will now be chiefly directed.—Condensed for the Scientific American Supplement from Prometheus.

In the opinion of the London Times, all who have experience of the mental and physical labor and of the material cost involved in scientific research will, in some measure at least, concur with the general principles put forward by a correspondent, who seeks to establish such investigations upon a basis of efficiency. His criticism of the present method of carrying out such researches is that in consequence of lack of organization there is repetition and redundancy, and that the successful experiment of a single individual is held back too long from common knowledge and from published experience. Of the research work conducted by the experimental departments of large firms he speaks with some bitterness, and says that the bulk of it is inefficient, that each firm buys its own experience, and that the interests of shareholders preclude the free exchange of information. He even goes so far as to suggest that in this country we lack the means of co-ordination possessed by Germany. It has nevertheless to be remarked that throughout the general range of industrial undertakings, depending upon a high standard of practical scientific knowledge, this country does nevertheless manage to keep ahead, and the published products of our research laboratories are neither mean nor trivial.

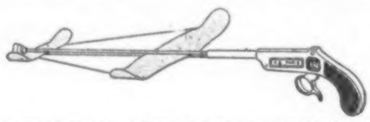
The issue can be better contemplated when scientific research is more rigidly defined, and when a distinction is drawn between things commercial and things educational. In general, industrial firms must keep secret the results of the researches for which they have paid, and up to a certain point there must be redundancy. But beyond the redundancy point, the firm that is ahead has discovered just a little more than its competitors and this increment secures orders and justifies the policy that otherwise might be described as lacking in efficiency. It must also be remembered that scientific discoveries cannot be forced into existence by the establishment of laboratories for purely scientific research. The most productive region for such discoveries is in the borderland between commerce and pure science.

UP-TO-DATE TOYS.*

NEW INVENTIONS IN PLAYTHINGS.

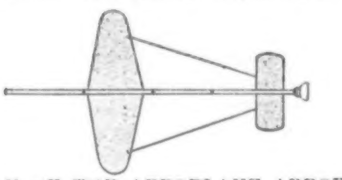
THE EUREKA AEROPLANE.

The well-known Eureka arrow carries at its tip a piece of India rubber in the form of a cup, which adheres to the target in the manner of a cupping-



THE EUREKA AEROPLANE ARROW AND PISTOL.

glass and holds the arrow horizontal. Hence the archer can see the result of each shot at once, without leaving his position, and the target is not injured or defaced, but can be used indefinitely. In the newest model, the arrow is provided with two sustaining planes with their ends bent upward, as shown in the



PLAN OF THE AEROPLANE ARROW.

illustration. Thus the arrow is converted into a toy aeroplane, its flight is steadied, its trajectory flattened and its range increased. The aeroplane arrow, like the ordinary Eureka arrow, is discharged from a spring gun, fashioned to resemble a rifle or a pistol.

THE TYMPANOPHONE.

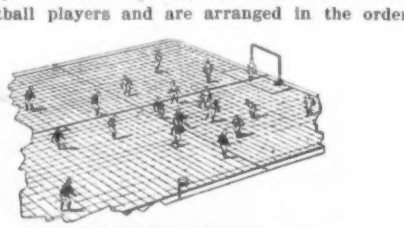
The musical toy called the tympanophone is composed of a wooden cylinder ending in a funnel, which is placed against the ear and held firmly in place by means of a handle, as is shown in the illustration. Pieces of watch spring, or similar elastic material, are attached to the cylinder and are set into vibration by striking them with a strip of India rubber about two inches long, fastened to the end of a wooden rod. If the metal reeds are cut to such lengths that they

THE TYMPANOPHONE.

give the proper musical notes when struck, the effect of a chime of bells can be produced by sweeping the bow across the reeds. This musical instrument possesses the advantage, or disadvantage, that its tones, though sounding very loud to the player, are inaudible to persons at a little distance. A number of persons may, however, enjoy the music by placing their ears in contact with a table, or even with rods pressed against a table on which the instrument is held upright, standing on its funnel, while it is played.

FOOTBALL CHESS.

A parlor game, which might appropriately be called Football Chess, has appeared in Paris, under the uncouth name of "Geogro." It is played by two persons on a board divided into a great number of squares. Each player has eleven pieces, which are made to imitate football players and are arranged in the order



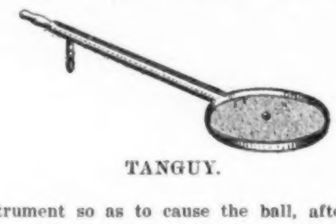
FOOTBALL CHESS.

of battle of football. The ball is represented by a counter, and it and the men are moved in accordance with the points obtained by throwing dice, and under the operation of rules which are devised to make the progress of the game imitate more or less closely that of a real game of football. The game may also be played by three or more persons, among whom the men are distributed.

* From La Nature.

TANGUY.

Tanguy is the name given by its French inventor to a very simple game of skill which is played with a little ball and an implement which greatly resembles a long-handled frying pan. The ball is placed at the end of the handle which, like the pan, is provided with a low rim. The game consists in manipulating

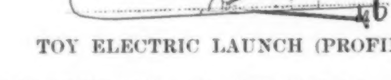


TANGUY.

the instrument so as to cause the ball, after it has rolled down the handle, to lodge in one of several depressions in the bottom of the pan. Each depression is marked with the number of points in the game which are made by lodging the ball in it. The depression at the center of the pan is the most difficult to make and bears the highest number.

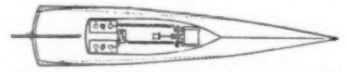
TOY ELECTRIC LAUNCH.

A Paris toymaker has succeeded in producing a toy electric launch which weighs only 4½ pounds and attains a speed of 4 1-3 miles per hour. The electric



TOY ELECTRIC LAUNCH (PROFILE).

motor weighs little more than 12 ounces. The current, of 8 amperes and 4 volts, is furnished by storage batteries weighing less than 5½ ounces. The hull is very long and narrow with an exceedingly sharp bow and a blunt stern, so that the outline is very nearly triangular and resembles that of the forward



TOY ELECTRIC LAUNCH (PLAN).

half of an ordinary launch. The machinery is placed near the stern, so that the bow tends to rise. This arrangement, and the very fine lines of the boat, enable it to attain considerable speed with the expenditure of very little power.

"CHICAGO," A NEW GAME.

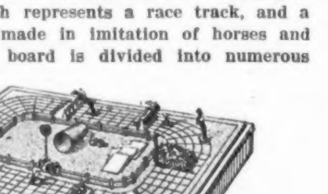
"Chicago," a new parlor game, is played on a small oblong board with rounded ends, which is mounted

"CHICAGO."

on a pivot and provided with a handle, by which it can be inclined in any direction. A row of six holes extends along the middle line of the board, which is surrounded by a rim about one inch high. Six wooden balls are placed on the board. The game consists of causing the six balls to enter the six holes by tipping the board. The holes at the ends of the row can be fitted with balls without much difficulty, but when this has been done the balls already holed prevent the remaining balls from reaching the middle holes, so that a good deal of skill, practice, and patience is required to hole all the balls.

THE STEEPLECHASE.

The Steeplechase is a new game which is ingenious and interesting, if not strikingly original. It is played with a board which represents a race track, and a number of pieces made in imitation of horses and their riders. The board is divided into numerous



THE STEEPLECHASE.

squares and, at each move, the player advances his horse by a number of squares determined by a throw of the dice. Some of the squares represent hedges, streams, walls and other obstacles. When the throw would bring the piece to one of these squares, it is not advanced, but is moved backward by a number of squares determined by the rules of the game. Some of these obstacles are assumed to cause the death of the horse or the jockey and, consequently, the loss of the race.

A POCKET BILLIARD CUE.

A French inventor has devised a billiard cue that can be carried in the pocket. It is not intended for use on a full size billiard table, but rather for parlor

POCKET BILLIARD CUE.

and children's billiards. The cue is a copper tube *A*, inclosing a spiral spring *B*, which is terminated at one end by a leather tip *D*, and at the other end by a knob *C*. The tube is held in the left hand, with the tip nearly in contact with the ball. The knob is then drawn back with the right hand and let go. The contraction of the spring causes the knob to strike violently against the rear end of the tube, and the shock of the impact is communicated through the tube to the tip at the front end, and thence to the ball, which is driven swiftly forward.

THE SONATINA.

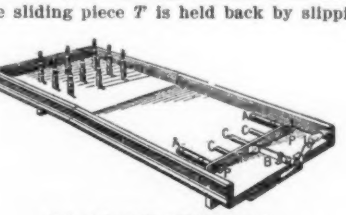
The Sonatina is a musical toy which is as simple as it is ingenious. It consists merely of a series of tongues or reeds, of tin-plate, tuned accurately to the notes of the musical scale by cutting them to the proper lengths, and fastened horizontally, by one end,

THE SONATINA.

above a sounding box. The instrument is played by dropping bird shot on the reeds from a receptacle having the form of a long slender tube, with a curved mouthpiece. The fall of the shot is regulated by turning the tube on its axis. The shot accumulate in the bottom of the box, so that the tube, when exhausted, is easily replenished.

BILLIARD-SKITTLES.

Billiard-skittles is a new French parlor game which combines some of the distinguishing features of billiards and skittles, or nine-pins. The nine pins are set up at one end of the board. At the other end is a sliding piece *T*, which can be drawn back to the edge of the board by pulling the rod *B*. This action stretches two spiral springs contained in the tubes *AA*. The sliding piece *T* is held back by slipping the

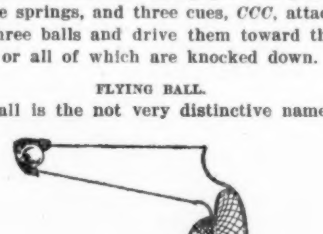


BILLIARD-SKITTLES.

end of draw-rod *B*, which bears a knob, into a notch at the edge of the board. When the rod is released by pressing the lever *L*, the sliding piece is pulled forward by the springs, and three cues, *CCC*, attached to it, strike three balls and drive them toward the nine pins, some or all of which are knocked down.

FLYING BALL.

Flying Ball is the not very distinctive name given



FLYING BALL.

to a new French game, which is played in the open air by two persons, and which combines the features of hand ball and tennis. Each player is provided with a racket, of the type shown in the illustration,

which is used both for throwing and for catching the ball. The ball is placed in a pocket of leather which is attached to the two prongs of the racket by bands of India rubber, the elasticity of which aids in concentrating the energy expended by the player upon the ball at the moment when it leaves the pocket, so that it is discharged with great velocity. The ball is caught in the conical net which is attached to the lower parts of the prongs of the racket. In another form of racket the throwing fork and sling are attached to one end of the handle, and the catching net to the other end.

THE PLANETS AND THEIR MOTIONS.

PROGRESSION AND RETROGRESSION.

As a rule, the apparent motion of the planets is from west to east; it is then termed "progressive." At times an individual planet appears fixed, or, as the term is, "stationary," for a period. At other times its motion may be "retrograde," i. e., from east to west. Inasmuch as the planet also changes its distance north or south from the equator, its path, at the time of transition from progressive to retrograde motion, forms a so-called loop. Three different types of such loops are shown in Figs. 1, 2, and 3. In Figs. 1 and 3 the apparent motion of the planet is progressive from *a* to *b*, at *b* the planet is stationary, from *b* to *c* it has retrograde motion, at *c* it is once more stationary, and finally from *c* to *d* its motion is again progressive. In Fig. 2 the two stationary positions *b* and *c* coincide.

To account for these observations it was supposed by the ancients and in the middle ages that each planet describes in space a circular orbit, an "epicycle," the center of which itself revolves in a circle around the earth, the latter being fixed. The path produced by such motion is shown in Fig. 4.

This theory of epicycles was refuted by Copernicus, who showed that all planets revolve from west to east in nearly circular orbits around the sun. This immediately furnishes a simple explanation of the "loops" in the paths of the planets. In Figs. 5 and 6 let *S* represent the position of the sun, and let the circle *E* be the earth's orbit, and the arc *J* a portion of Jupiter's orbit. Both the earth and Jupiter, as planets, revolve from west to east around the sun, i. e., with progressive motion, as indicated by the arrows. Further, let the arc *F* represent a portion of the apparent firmament.

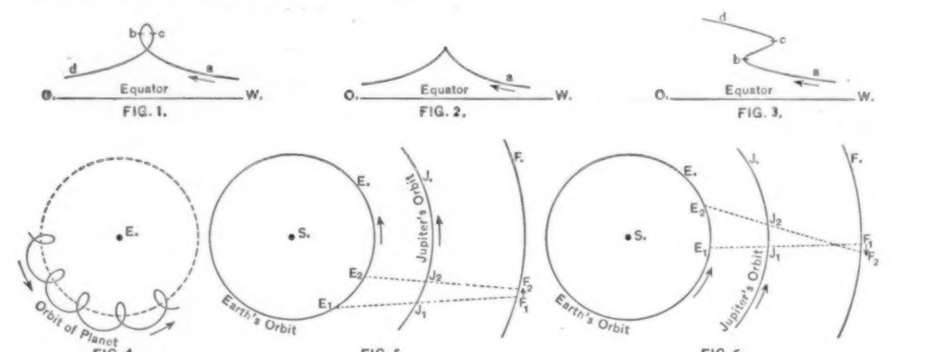


DIAGRAM EXPLAINING THE APPARENT MOTIONS OF THE PLANETS.

Now consider Fig. 5. At the moment when the earth is at E_1 let Jupiter be at J_1. The latter will then be seen by an observer on the earth in the direction E_1 J_1 F_1, and appear standing at point F_1 in the firmament. Now let the earth move from E_1 to E_2, while Jupiter advances from J_1 to J_2. Jupiter will then be seen from the earth in the direction E_2 J_2 F_2, and appear standing at F_2 in the firmament. Thus the apparent motion of Jupiter has been from F_1 to F_2, west to east. In this case, then, the apparent motion of Jupiter, as well as its actual motion, is progressive.

Passing now to Fig. 6, the symbols of which are to be interpreted as in Fig. 5, we note that in the first position Jupiter will be seen from the earth as standing at F_1 in the firmament, in the second position at F_2. Here then, although the true motion of Jupiter is, as before, from west to east, its apparent motion is retrograde, from east to west.

Evidently, at some stage between that indicated on Fig. 5 and that shown on Fig. 6 there must be an intermediate position, when Jupiter is apparently at rest.—Translated for the Scientific American Supplement from Kosmos.

THE MARKINGS OF MARS.

In a recent number of Nature, Mr. James H. Worthington communicates the results of an interesting month spent at the Lowell Observatory, Flagstaff, Arizona, where he had an opportunity of ascertaining for himself just how much can be seen of the much-discussed markings on Mars, through Mr. Lowell's 24-inch refractor.

"When I first looked at Mars at Flagstaff (September 27th, 1909) I saw with great difficulty three streaks, presumably canals," Mr. Worthington tells us. "The seeing was bad, and the general faintness of the planet's markings at that time is admitted by all. I continued to observe Mars on every possible night (which was nearly every night) until October 25th, and as my eye became accustomed to the work I saw more and more. The canals were seen repeatedly better—this with the 24-inch refractor generally stopped down to about 18 inches. I found that with more than 20 inches the air was nearly always too unsteady, and with less than 15 inches too much separating power was lost. The canals were seen best with a power of 390 diameters.

"Clearer they became each night until, on October 25th, the seeing being the best I ever experienced, the canals came out with amazing clearness and steadiness, sharp and clean, like telegraph wires against the sky, the oases also being exquisitely defined. Whereas on previous nights the canals could be held only by short glimpses of perhaps half a second at a time, they were now steadily visible for three or four seconds together, when a short flicker would sweep over them; during the lucid intervals the limb also of the planet was perfectly steady, as I have never seen it before or since. Of the objective existence of these markings in the image at the focus of the telescope there could be no manner of doubt, and Lowell's representations of them are nearer the actual appearance than any I have seen, though even in his drawings the lines seem hardly fine enough. The effect produced on my mind by this remarkable definition, which lasted for upward of one and a half hours (from about 8:30 until after 10 P. M.), was staggering and ineffaceable. Soon after ten the definition went to pieces.

"It may be relevant to mention that a few evenings previously I had obtained a fair and convincing view of the canals with the 40-inch reflector (full aperture and a power of about 700), when they had appeared hazy and broader, but the image had been very unsteady, and only obtained in very short flashes; but nothing that I had hitherto seen had prepared me for the astonishing steadiness and *fineness* of the details visible on this superb night.

"There is in my mind no sort of doubt that the revelation of this night was due both to the perfection of the instrument (which its maker long ago pronounced to be the best that the firm of Alvan Clark ever turned out) and the atmospheric conditions which are found at Flagstaff. With respect to these I would mention, as pointing to the freedom from water vapor, that I have seen the thermometer fall from more than 70 deg. F. at 3 P. M. to below the freezing point at 3 A. M. without a trace of hoar-frost, and the general clearness of the air was such that I could see Uranus with the naked eye within 5 deg. of the horizon, and could nearly every night count nine stars in the Pleiades and separate ε and 5 Lyræ.

"The telescope also afforded on other nights ample evidence of the extraordinary clearness of the air. On many occasions both satellites of Mars, when not very near the limb, could be seen, without screening the planet, with 18 inches of aperture; and on one occasion with this aperture I picked up one of them unawares while looking for canals with *a yellow screen*. (N. B.—The importance of color screens in rendering the canals visible does not seem to be sufficiently appreciated.)

"In the face of all this positive evidence, and in the absence of any evidence that the observing conditions at Muedon, just outside Paris, ever approach these best conditions at Flagstaff, I find it impossible myself to attach any serious weight to the ingenious and plausible contentions of M. Antoniadi, which seem to have been much too hastily accepted in this country.

"As to the deductions which Dr. Lowell has drawn from his observations, I have nothing to say except that the startlingly artificial and geometrical appearance of the markings did *force* itself upon me."

SURFACE TENSION AND VITAL PHENOMENA.

Dealing with the nature of life and the past record of biological research, Prof. A. B. Macallum, F.R.S., before the British Association for the Advancement of Science, concluded by saying: "I am well aware of the fact that my treatment of the subjects discussed has not been as adequate as their character would warrant. The position which I occupy imposes limits, and there enters also the personal factor to account in part for the failure to achieve the result at which I aimed. But there is besides the idea that in applying the laws of surface tension in the explanation of vital phenomena I am proceeding along a path into the unknown which has been as yet only in a most general way marked out by pioneer investigators, and in consequence, to avoid mistakes, I have been constrained to exercise caution, and to repress the desire to make larger ventures from the imperfectly beaten main road. Perhaps, after all, I may have fallen into error, and I must therefore be prepared to recall or to revise some of the views which I have advanced here, should they ultimately be found wanting. That, however, as I reassure myself is the true attitude to take. It is a far cry to certainty. As Duclaux has aptly put it, the reason why science advances is that it is never sure of anything. Thus I justify my effort of to-day. Notwithstanding this inadequate treatment of the subject of surface tension in relation to cellular processes, I hope I have made it in some measure clear that the same force which shapes the raindrop or the molten mass of a planet is an all-important factor in the causation of vital phenomena. Some of the latter may not thereby be explained. We do not as yet know all that is concerned in the physical state of solutions. The fact, ascertained by Rona and Michaelis, that certain sugars, which neither lower nor appreciably raise surface tension in their solutions, condense or are absorbed on the surface of a solution system, is an indication that there are at least some problems with a bearing on vital phenomena yet to solve. Nevertheless, what we have gained from our knowledge of the laws of surface tension constitutes a distinct step in advance, and a more extended application of the Gibbs-Thomson principle may throw light on the causation of other vital phenomena. To that end a greatly-developed science of microchemistry is necessary. This should supply the stimulus to enthusiasm in the search for reactions that will enable us to locate with great precision in the living cell the constituents, inorganic and organic, which affect its physical state, and thereby influence its activity."

The Bureau of Fisheries has recently issued a bulletin bearing the title "Influences of the Eyes, Ears, and Other Allied Sense Organs on the Movements of the Dogfish." The author of the pamphlet, Dr. G. H. Parker, of Harvard University, comes to the conclusion that the eyes of the smooth dogfish are the only receptive organs for light possessed by this animal. The dogfish reacts with sufficient accuracy to the details of its retinal images to show that it has moderately sharp vision. When the sharpness of its vision is greatly reduced, it becomes simply positively phototropic. The ears of the dogfish are organs of hearing, and are concerned with equilibrium and muscular tonus. The removal of their otoliths interferes with hearing, but not with their two other functions. The lateral-line organs are stimulated by vibrations of low frequency and by pressure. They are relatively insignificant as organs for the control of equilibrium. The ampullæ of Lorenzini are stimulated by pressure, and are doubtless closely related in origin and function to the lateral-line organs. The whole integument of the dogfish is a receptive organ for mechanical stimuli. From it arise impulses for the movement of the nictitating membrane, and for a complicated system of correlated fin movements, most of which are concerned with locomotion and equilibrium.

A NEW MAP OF THE WORLD.*

THE INTERNATIONAL MILLIONTH MAP.

BY BAILEY WILLIS, U. S. GEOLOGICAL SURVEY.

"FOR whatever the stature of his guest, however tall or short, that bed fits him to a hair. Because, if a man be too tall for it he lops his limbs till they be short enough, and if he be too short he stretches his limbs till they be long enough. Therefore is he called Procrustes the Stretcher."

Turn the leaves of any atlas and view the countries, large or small. How they are all fitted to the Procrustan page, some drawn to one scale and some to another, but all finally compressed to the same size in the atlas, although widely different in fact. Here is Colorado with 103,925, or Wisconsin with 56,040, or Massachusetts, Connecticut, and Rhode Island, all three together with but 14,555 square miles; but the last, like the first, precisely fills the page. If, in Massachusetts, there be two towns 12 miles apart, there is an inch between them on the map, but if in Colorado there are two 29 miles apart, they also appear upon the map within an inch of one another, the scale in the one case being 12 miles to the inch and in the other 29 miles to the inch.

This adjustment of the maps in an atlas to different scales to suit the size of the page appears necessary, because each page should be fully covered and the States or countries which need to be separately mapped are very unequal in size. In local thought the county is larger than the State and the State larger than the whole country, and atlases are made for local use.

But if we would take a broader view of the world and of nations, wishing to know something of the comparative size of countries—that France, for instance, is about four-fifths as large as Texas—it would be at least a great convenience to have an atlas of the world in which all lands were mapped to the same scale. Such an atlas the International Millionth Map of the World is to be.

The name signifies that the map is to be drawn on a scale of one to one million; that is, that any length measured upon the map is to be one-millionth part of the distance between the same two points measured on the ground. In the metric system this is equivalent to saying that a meter on the map is equal to a million meters or 100 kilometers on the ground. In our English measure it is equivalent to about sixteen miles to the inch. This is a fairly large scale, which allows the engraver to delineate villages as well as cities, railroads and the principal roads, all watercourses of note, and the general features of hills and mountains. Yet the scale is also such that a sheet of convenient size may represent a large area, on an average equivalent to a State of the United States, and thus the scope of the map is sufficiently generous to be useful.

Both in scale and scope we may contrast this one-millionth map with others which are made available to the public by the government surveys. The detailed topographic maps of the United States, which are prepared by the United States Geological Survey from original surveys, are published on a scale of one mile to an inch for the more densely settled regions of the country and of two miles to an inch for the less developed regions. This scale is so large that it is possible to show individual houses, every turn of the roads, and the precise form and altitude of all noticeable hills. With these maps, in advance of other surveys, an engineer may plan the route of a road or even a railroad through a hilly or mountainous country. Thus they are adapted to all detailed studies of local features, but their scale is so large that their scope is very small. By train or automobile we may traverse the area represented on a single atlas sheet in an hour or two, and one cannot conveniently carry enough sheets to trace the course of an extended journey.

In reducing the scale to 16 miles to the inch we reduce also the details which may be shown, and we must necessarily eliminate the local objects. But that scale is still sufficiently large to comprise all of the essential features which one would wish included in a general view, and the scope becomes such that a single sheet serves for a day's journey.

Maps of various parts of the United States, which approach the one-millionth in scale and scope, are not uncommon. Land office maps, prepared by the general government, and State maps designed for different purposes have not infrequently been published with 10, 12, or 15 miles to the inch, and for some years past the Geological Survey has had maps in preparation with the design of publishing them on the one-millionth scale. But it has awaited the conclusion of an international agreement before pushing them to publication.

THE ORIGINATOR OF THE PLAN.

It was in 1891 that the proposal for a standard international map of the world was first made by Prof. Albrecht Penck, then professor of geography at the University of Vienna and now at the University of Berlin. Prof. Penck, who was at that time a young and comparatively little known man, might have found it difficult to arouse interest for his plan except that he was able to bring it before the International Geographical Congress which met in Bern in that year. The geographers who were there assembled knew from their own experience the great inconveniences which arise from the use of maps on many scales, and they appreciated the great advantage which would accrue to the study of geography if we could but have one standard map on a uniform scale. They therefore took up the project, passed resolutions favoring it, and committed the plan to a committee with instructions to report at the succeeding congress.

The members of the committee represented ten different countries and were twenty in number. The list of names includes the leading geographers of the time and men high in official rank, whose duties in other directions were already onerous. Mr. Mendenhall, superintendent of the Coast and Geodetic Survey, and Major Powell, director of the Geological Survey, represented the United States. It might have been foreseen that so large a committee would be ineffective, because it was impossible to assemble the members for discussion. Recognizing the need of an efficient subcommittee to study the problem and formulate proposals, the general committee invited three representative scientists of Switzerland, at the head of whom was Eduard Brückner, then professor of geography at the University of Bern, to act in an advisory capacity, and to this subcommittee is due the credit of such progress as was made in the development of the question. A report submitted by Prof. Brückner at the Sixth International Geographical Congress at London, in 1895,* contains a discussion of all the principal items on which agreement was necessary, and presents clearly the difficulties which arise from different usages in cartography.

But if the general committee failed as an executive body, it served most excellently to make the plan widely known, as is shown by the list attached to Prof. Brückner's report of twenty-one articles published in the interval between the two meetings of 1901 and 1905.

At the Geographical Congress held in Berlin in 1899, Prof. Penck again brought forward his plan for a world map, but the difficulties of adjusting national differences seemed insuperable. Prominent among these were the absolute refusal of the English geographers to accept the metric system and the insistence of the French geographers upon the meridian of Paris as the initial meridian of the international map.

IMPORTANT PROGRESS AT THE WASHINGTON MEETING.

At the Eighth Congress, held in Washington in 1904, Prof. Penck took advantage of the fact that France, Germany, and Great Britain had separately prepared maps, on a scale of one to one million, of countries as far apart as China, India, Persia, Africa, and the Antilles, to congratulate the assembly upon the progress made toward the world map. Setting aside as relatively inconsiderable the differences in arrangement and execution of the several maps, he dwelt upon their uniformity of scale and took a hopeful view of the outlook for future agreement. He said:

"It is thus for the first time that different parts of the earth's surface are represented so that they can be directly compared with one another. One who is familiar with Cuba needs only to lay the French map of this island at the side of the German or French map of China to see at one glance that space which has been overwhelmed in the Russo-Japanese war. A student of the coast line can now compare the bays of Shantung with those of Cuba, and another can compare the behavior of the rivers in south Abyssinia with those in south China, and a third will be able, by the chosen projection, to determine the exact areas of lands, rivers, basins, lakes, and so on. All this indicates considerable progress in the practical and theoretical study of different parts of the world—a progress which is not essentially affected by the fact that the maps are not so uniform as was desirable."

After discussing the differences existing among the maps undertaken by the European powers, Prof. Penck pointed out that there was no general map of North or South America, or even of the United States, such as any student or traveler requires, and he urged that the Geographical Congress should endeavor to induce the United States to do for America what Great Britain is doing for Africa; that is, to prepare a uniform map of both the American continents on a scale of one to one million.*

The action of the Eighth Congress led to no official result, but the arguments presented by Prof. Penck for a general map of the United States bore fruit in the work of the Geological Survey. By authority of the director, Mr. Walcott, Mr. Henry Gannett prepared a number of maps designed to become part of the one-millionth map of the United States. They were, however, not adjusted to any general plan of the map of the world, as no international scheme had then been agreed to. The units chosen were States, and the drawings were made in accordance with the methods of cartography which have become familiar through the atlas sheets of the Geological Survey. The representation of altitudes by brown contour lines was worked out in great detail for the scale, and peculiarly distinguished the maps in contrast to the effects of shading employed by the French and German cartographers.

Mr. Gannett's interest in the project for a world map became an important factor in its further development. At the Ninth International Geographical Congress, held at Geneva in July, 1908, he presented through the American delegate, Dr. David T. Day, resolutions urging that the Congress take effective measures toward an agreement upon the essential details of the plan, and that these measures be commended to the several map-making powers with a request for an international conference having authority to act upon them. The resolutions were passed, a committee was appointed, and the details of a plan were worked out and adopted. The British representative, Col. C. F. Close, on request of the congress, accepted the responsibility of presenting to his government a suggestion for a conference at London. And thus the plan which a few years before had seemed hopeless of accomplishment was brought within promise of fruition.

THE CONFERENCE AT LONDON.

In the summer of 1909 the British government issued invitations to Austria-Hungary, France, Germany, Italy, Japan, Russia, Spain, and the United States to send delegates to a conference to assemble in London on November 16th, with power to agree upon details of the standard international map of the world. All of the governments accepted except Japan, and twenty-two delegates assembled in the British Foreign Office in the council room where Lord Salisbury had been wont to hold the meetings of his cabinet.

The sitting of the conference was dignified and impressive. The great square chamber was furnished with a round table, at which all the delegates were seated within convenient range for discussion. There was a touch of old England in the soft-coal fire, which dispelled the chill of London in November, and the bunch of quill pens spread before each member was a reminder of the historic documents that had been executed in Britain's capital.

Under the presidency of Col. S. C. N. Grant, of the British Ordnance Office, assisted by Col. C. F. Close, of the General Staff, the deliberations of the conference were conducted not only with courtesy, but with impartiality and fairness. These officers had but one purpose in view: to ascertain the wishes of a majority of the delegates and secure such an expression of opinion as would lead to a unanimous conclusion. And in this they were signally successful.

In the circle sat men who had been associated with the project since its beginning, and who rightly felt a deep sense of satisfaction in its fruition. Prof. Penck, the originator of the plan and now the representative of the Emperor William, was the leading figure, but he took his part with that scientific spirit which effaces the personal element, and a bystander unfamiliar with the past history of the plan would not have known from anything which he said that it had sprung from him. Across the table from him

* The National Geographic Magazine.

* Brückner, E. Rapport du Président de la Commission pour l'Establissement d'une Carte de la Terre a l'Echelle de 1:1,000,000. Report of Sixth International Geographical Congress, London, 1895.

* Penck, Albrecht. Plan of a map of the World. Report of the Eighth International Geographical Congress, pp. 558-557. Washington, 1904. In the same report is a notice by General Berthaut of France and one by Major Hills of England, on the one to one-millionth maps in preparation by their respective governments.

sat Eduard Brückner, who, holding the professorship at Vienna which had been vacated by Penck's transfer to Berlin, was the leading delegate from Austria. France was represented by several eminent geographers, of whom Charles Lallemand, a distinguished geodesist, shared with Prof. Penck a commanding position among the foreign delegates. Around the table were many others whose names are well known as teachers and writers on geographical subjects. The delegates from the United States were Mr. S. J. Kübel, chief engraver of the U. S. Geological Survey, and Mr. Bailey Willis, geologist of the same service.

FRANCE ACCEPTS THE GREENWICH MERIDIAN AND ENGLAND RECIPROCATES BY ACCEPTING THE METER.

The conference took up one by one the proposals of the General Congress and debated them in English, French, or German, as the convenience of any individual speaker prompted. There had evidently been much preliminary discussion at home, and there was a dominant purpose to arrive at a satisfactory conclusion which swept away all the international differences that had previously prevented agreement. The initial meridian of Greenwich was adopted unanimously, without debate. The metric system was agreed to by the English and American delegates, with the provision that the scale of distances might also be stated in terms of miles or of any other unit (such as Russian versts) of the country producing a part of the map. The acceptance of the metric scale extended also to the statement of altitudes above the sea, with the proviso that the height in feet may be given in parentheses after the number in meters. The conventional symbols to be used for representing water courses, roads, railroads, towns, cities, and the names of various features were agreed to in detail after thorough discussion by a large subcommittee. The result embodies practically all the conventions used by the United States Geological Survey, in the form in which they are employed in the government maps.

"FLORENCE," "ROME," "VIENNA" WILL DISAPPEAR FROM THE MAP.

In writing and spelling names the Latin alphabet alone may be used, and the spelling shall be that of the official maps of the country represented. Thus the international map will show nothing of Russian or Chinese script. You will look in vain for Florence, but will find Firenze; instead of Rome, Roma; of Flushing, Vlissingen; of Vienna, Wien, and so forth. There was no dissent from this last ruling except in one instance. In odd contradiction to the general liberality of feeling, it was emphatically declared that European geographers could not permit Stamboul, the Turkish name, to replace Constantinople. For China the adopted spelling was to be that of the post and customs service, and in all colonies or protectorates the names are to be spelled in accordance with the usage of the governing country. The delegate from Hungary presented the grave difficulty which confronts the cartographer in the fact that nearly all Hungarian towns have two names, one Hungarian and the other German, and some of them have as many as five names, all of which are currently used by the distinct elements of the population. But it was pointed out that this difficulty affects but one or two sheets of the great atlas of the world, and that the question of choosing among these names might well be left to the Hungarian government.

HOW ELEVATIONS WILL BE INDICATED.

There is perhaps nothing which more strikingly distinguishes new maps from old ones, or maps of one nationality from those of another, than the manner in which valleys, hills, and mountains are represented, whether it be by drawing the shapes of mountains, as in Chinese maps, or by covering the paper with short dashes, sometimes called hachures, which show the way the water runs, or by horizontal lines that delineate the contours of the slopes, or by shading with high light and shadow, as if the map were a relief model. Hachures, contours, and relief shading, or combinations of two or even of all three methods, characterize modern topographic maps, and one of the most difficult questions before the conference was to harmonize the various methods in current use.

In maps prepared by the United States Geological Survey contour lines alone are used, and the delineation of mountain forms by means of them has been brought to a higher degree of graphic expression than ever before. This is due to the fact that the American topographer regards his work as a profession rather than as a side issue of military training, which is the position which holds abroad.

In Germany and Austria the method of exhibiting slopes by means of hachures has replaced all other systems, because it is so applied that the proportion of dark lines to intervening light spaces bears a mathematical relation to the steepness of the slope. Level plains are white, and slopes of 45 degrees are almost black, and other slopes are shaded according to their grade. These maps are peculiarly adapted to military purposes, since an officer can judge at a glance the nature of a declivity and whether it is passable by infantry, cavalry, or perhaps artillery; but these advantages do not everywhere have weight, and the method is one which is too expensive in execution and too limited in usefulness to be widely adopted. France has brought relief shading to a very high degree of perfection, and leads the world in the artistic beauty of her topographic maps.

The method of representing the topographic relief of the surface which the conference adopted consists in the main of generalized contours, which shall be so drawn as not to unduly obscure other features of the map, and, in addition, shading is to be used to bring out those minor features which cannot be adequately represented by contours.

The map up to this point will comprise the representation of streams and all water bodies, of towns, railroads, and highways, of political boundaries, of the topographic relief, and the names pertaining to all these features. It will be what may be called a base map, adequate in itself for all ordinary uses of the student and the traveler, but capable of receiving additional data which convert it to a special purpose. In connection with our census, it might be used to express density of population by overprinting different shades of color. Similarly, it might be used as a crop map, a weather map, or a geological map, or to bring out the relations between lines of transportation or works of internal improvement, whether national, state, or private. Thus this base map contains in itself and in its adaptability to a large number of purposes the highest possibilities for usefulness.

The conference in London, having had its origin among geographers, felt constrained to emphasize the geographic side of cartography, and particularly the representation of altitudes of continents and mountains with reference to sea level. These relations are indeed adequately expressed by contours, if one examines the map with sufficient care, but it is desirable, especially upon a general map of large scope and moderate scale, to bring the distribution of altitudes more strikingly into view. To that end the conference adopted a scale of colors, which should be printed on different portions of the map, according to the height above the sea. The depths of seas and lakes shall be shown by shades of blue; the lower lands, from the coast to 300 meters (984 feet), by three tints of green, shading into pale buff, which at 500 meters passes into light browns, that grow darker up to 3,000 meters. Above 3,000 meters the brown tints tone into rosy violet, and fade away to white in the highest summits beyond 7,000 meters.

As applied to the United States, the effect of this color scheme will be to exhibit light tints of green and buff over the Atlantic slope and throughout the Mississippi Valley, and from their expanse the Appalachian Mountains will stand out in tones of brown. Similar brown tints will indicate the rising plains between the Mississippi Valley and Colorado, while the summits of the Rockies and of the Cordillera will carry the violet notes of high altitude. On the Pacific slope the bands of color will be closely crowded, bringing out at once the gradations in tint and the relatively rapid rise from the sea to the mountain crests.

THE ATLAS WILL CONTAIN ABOUT 1,500 SHEETS.

The arrangement of sheets of the one-millionth map is shown for the northern hemisphere on the accompanying diagram. It will be noticed that each sheet measures 4 degrees of latitude by 6 degrees of longitude. Thus 60 sheets belt the earth, and 22½ sheets extend from the equator to the pole. In the discussions of the conference the execution of the circular sheet covering the northern polar regions within the parallel of 88 degrees was courteously committed to the United States. To represent an entire hemisphere would thus require 1,321 sheets, and for the entire world twice that number; but since three-fourths of the earth's surface is ocean, the atlas will probably never comprise more than 1,500 sheets, including the oceanic islands. These sheets are so designed that they may be fitted together, without appreciable gaps, to any number that may reasonably be placed upon a single wall, and since they will be executed through international co-operation, without reference to national boundaries, according to a uniform style and method, they will really constitute a single great map of the world.

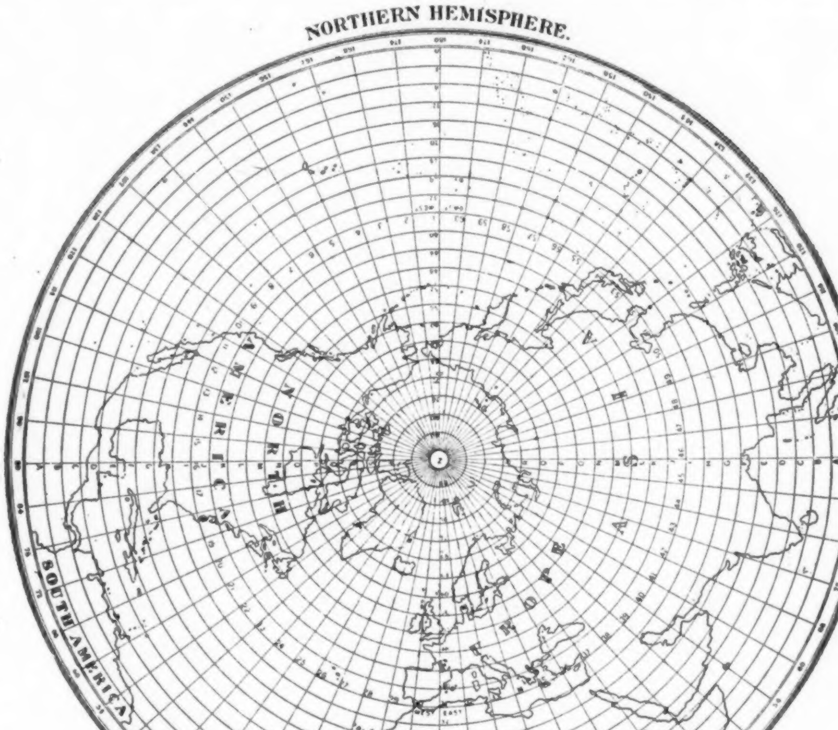


DIAGRAM SHOWING ARRANGEMENT OF SHEETS FOR THE INTERNATIONAL MAP ON THE SCALE OF 1:1,000,000.

THE MAP SHEETS OF THE UNITED STATES.

The sheets which fall upon the area of the United States, including parts of the adjacent oceans and of Canada and Mexico, but excluding Alaska, are 52 in number. The United States Geological Survey now has in course of preparation nine of these sheets, covering parts of the Eastern, Central, and Western States. The originals are being drawn on a scale of one-five-hundred-thousandth, or 8 miles to the inch, and in such a manner that they may be reproduced by photolithography in a clear and effective manner for publication on a scale of 10 miles to the inch. In this form the maps may become immediately available for use by the departments of the government or by individual States; and eventually, as Congress provides the means, they will be engraved and published on the scale of one million (16 miles to the inch), with all the details required by the decisions of the international conference at London. It may be assumed that they will then be available to any one at the cost of paper and printing, as is now the case with the topographic atlas sheets prepared under the same auspices.

ALL GOVERNMENTS UNITE TO COMPLETE THE MAP.

The unanimous conclusions of the London conference have pledged the great powers to the standard

map of the world, which Prof. Penck proposed eighteen years ago. The need of that map is greatest concerning the countries which have been least adequately mapped, and among these we must count both Americas, as well as Africa, Asia, and Australia. Good maps exist of all of Europe, ranging in scale all the way from one to twenty thousand up to one to one and a half millions.

For Europe the data are all available, and the preparation of the one-millionth map is a question of a contract between some one of the great publishing houses of England, France, or Germany and the governments that are interested. It was understood at the conference that the work would thus be committed to one establishment, so far as Europe was concerned, in order that uniformity might be secured.

But the United States government is gathering the original data for the mother maps of this country, and is compiling and publishing them at a cost much below that which a European publisher would necessarily charge. It, therefore, through its delegates at London, declined to send the original data to Europe, and reserved to itself the preparation of these original maps. It is to be hoped that the task may be prosecuted with energy, and that the first edition of the one-millionth map of the United States as a part of the standard map of the world may be engraved and published within ten years.

This compilation will then represent the state of knowledge at the time of completion of each sheet. As surveys progress, corrections and additions will be necessary, the progress of improvement in the map will become an index to the progress of civilization in our country.

In the Zeitschr. Vereines Deutsch Ing., G. Klingenberg describes his studies of helicopters. It seems that experiments were made on lifting propellers running coaxially in opposite directions, and it was found that the aggregate effect exceeded the sum of the effects of the two propellers running separately if care was taken to make the air enter the lower propeller at a suitable angle. Instead of the lifting force P and the work N the coefficients $c_p = P/n^2$ and $c_w = N/n^3$ were found for various pitches, n being the frequency of the revolution. The results show that c_p varies within wide limits, these being about 0.035 and 0.25. The smallest value is obtained with small flat propellers moving close together, and the largest with curved propellers at a considerable interval. The coefficient c_w is always larger than c_p, and it increases with the roughness of the wings and the proximity of the propellers to each other. In small fast propellers $c_w = 1.1\, c_p$ approximately, and in large, slow ones it is 1.02 c_p. Experiments made on small ventilators 65 centimeters in diameter, on the one hand, and large propellers 6 or 8 meters in diameter on the other, all show that the greatest effect is obtained when half the circumference is taken up with propeller blades. When the blades are sufficiently numerous to fill up the whole circle there is a slight diminution of efficiency. The most interesting result is that two propellers of 6 and 8 meters diameter and large surface could be made to lift 530 kilogrammes with a power of 93 horse-power. The weight of propellers, gearing, and framework can hardly be less than 170 kilogrammes, which leaves 360 kilogrammes for motor, fuel, and one aviator. This does not hold out much prospect of success at present, but does not, on the other hand, make the helicopter principle look hopeless. Compared with aeroplanes, the helicopter has the advantage of stability and safety in starting and landing. The grave danger of a breakdown of the motor may be met by making the propeller blades very large or adding auxiliary planes.

ELECTRICAL NOTES.

Following the experiment made in England, the French navy department is installing wireless apparatus on the submarines "Berthelot" and "Prarial" stationed at Cherbourg. A long antenna will be used so that messages can be taken by the submarines even when submerged. In this way the maneuvers of the submarines can be commanded by the chief officer of the fleet.

Last year a cable was laid under the Pacific Ocean from the Fanning Islands, south of Hawaii, to Bamfield Creek on the west coast of Canada. At the same time the construction of a telegraph line across the continent from Bamfield Creek to Montreal was commenced. The work is now completed and Montreal is connected directly with the Fanning Islands by a line 6,800 miles in length, more than half of which is under water. Messages sent by this route from London to Australia and the east coast of Asia gain 15 minutes in time of transmission over telegrams sent overland across the Eastern continent, owing to the suppression of two relay stations.

The international wireless telegraph business of the world is conducted under a treaty signed at Berlin on November 23rd, 1906. This treaty was the result of a convention which was participated in by twenty-six of the principal nations. Because the United States has not yet given its adherence to the convention, ships flying the American flag find themselves without standing in international wireless telegraphy; for none of the contracting countries is compelled to receive a telegram from the ships of a non-contracting country, and any coastal station in a foreign country may refuse transmission of a message to a station on shipboard subject to a non-contracting country. The chief signal officer of the United States army, in his report to the Secretary of War for 1910, recommends that the matter again receive attention, and, through the proper channels, be brought anew to the consideration of the United States Senate.

The "reach" of a wireless telegraph station is affected by solar radiation, the nature of the soil, the proximity of mountains, and various other circumstances. A station having a normal radius of action of only 100 kilometers is sometimes able to send messages 1,000 kilometers. These great occasional increases in reach have been observed only in the following districts: 1, the Gulf of Lyons; 2, the region between Cape Finisterre and Lisbon; 3, Port Said; 4, the Atlantic Ocean near longitude 10 deg. 15 min. W. and latitude 48 deg. 40 min. N.; 5, the district around Scheveningen. The exact cause of these phenomena is unknown, but the quantity of metal contained in the earth in the vicinity and the electrical state of the atmosphere appear to exert great influence on the propagation of electric waves. The reach of weak stations is greatly increased at night, probably because the ionization of the air is then correspondingly diminished by the absence of solar radiation. Some curious observations were made on a recent passage of the steamer "Bremen" from Naples to Genoa. During the night when the vessel left Naples, 336 miles south of Genoa, messages sent across the Alps from the station at Norddeich arrived with an intensity which we will denote by 1. At noon on the following day, when the ship was only 161 miles from Genoa, the intensity of the signals had fallen to 0.65. At night, when the vessel had reached Genoa, the intensity rose to 2.4, but it fell to 0.085 during the following day. It appears, therefore, that the daytime intensity decreased as the ship came nearer to the mountains, which scarcely exerted an appreciable influence at night. A moving wireless station cannot properly be said to have a normal or a maximum reach, for apparatus which can transmit signals to a great distance at 50 deg. north latitude may have a surprisingly small reach in the tropics, owing to the intensity of solar radiation.

SCIENCE NOTES.

The eyes of certain birds such as owls, eagles, and cocks, are provided with an organ which French naturalists, as the result of experiments, propose to call the "parasol." It is attached to the retina at a point where the optic nerve enters. It consists of a thin, black, opaque membrane. When closed it forms a narrow line lying in the optical axis, and not interfering with vision; when open it covers the retina and protects it from any strong light thrown into the eye. It is said that when a cock appears to be hypnotized by a strong light, the fact is that the bird has simply protected its retina with the "parasol," and when an eagle "looks at the sun," it does not see it. The membrane is impervious to both visible light and ultra-violet radiation.

Among practical devices for the application of the wave-length of light as a standard of fine measurement for scientific purposes is the elasmometer, an instrument to which are credited results in the accurate determination of changes of dimension or position too small to be ascertainable with precision by mechanical means, and often entirely invisible to the naked eye. In measuring, for instance, the bending, under slight weights, of bits of metal only two centimeters long, it is said that the elasmometer gives results which are probably more accurate than the best mechanical methods can give with bars of metal two feet long. In the elasmometer the interference bands produced by waves of red hydrogen light crossing from two reflecting surfaces furnish the means of measurement. The slightest bending causes the bands to sweep in orderly procession across the field of a powerful microscope.

The views held as to the behavior of dextrin in the finishing of textile fabrics are rather divergent. Some users complain that it dulls the colors and imparts to the cloth a hard, stiff handle, while others deny this. It would be very expensive to fill a cloth heavily with dextrin alone, and to reduce the cost it has been usual to add salts such as sodium or magnesium sulphate or magnesium chloride, to increase the weighting effect. Epsom salts (magnesium sulphate) have been most largely used, with an addition or Turkey-red oil as a softener. Starch treated with "diastafor" has been recently recommended as a substitute for dextrin, on the ground that it does not give such hard finishes as the latter, but Hastaden in the Faerber Zeit. does not agree with this and states that he uses it on account of the saving in cost. In his opinion there is no practical difference between dextrin and starch treated with diastafor, a pure dextrin giving the same reactions as a completely converted starch, while an impure dextrin behaves more or less like a starch which has been acted upon by diastafor only for a short time. With a pure dextrin a hard finish can only result from the use of too large a quantity in filling, while with an impure quality it is the unchanged starch which is responsible for the stiffness. Pure dextrin dissolves to a clear solution in cold water and such a solution cannot possibly dull the colors or whites; where this occurs it can only be that a poorly prepared product has been employed.

TABLE OF CONTENTS.

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0.085
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se to
at a
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the
para-
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the
sure-
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accu-
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cha-
aked
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eters
sults
me-
two
ands
ssing
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ands
of a

n in
gent,
and
thers
cloth
st it
mag-
rease
sul-
ition
with
sub-
not
aden
and
cost.
ween
pure
etely
aves
upon
pure
se of
pure
spon-
to a
can-
this
duct

Page.
386
395
398
391
386
389
388
400
389
392
398
387
387
396
400
387
390

Sc
Sc

the
est
it
the
and
wh

and
inch
larg
cyli
use
pass
term
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and
inte
ceiv
cyli
A
cyli
cyli
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the
valv
port
This
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T
125
is 7
luti
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